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[No. 34.]

N.E. COTTON MANUFACTURERS' ASSOCIATION.

PROCEEDINGS

OF THE

EIGHTEENTH ANNUAL MEETING,

HELD AT BOSTON APRIL 25, 1883.

PRECEDED BY

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Total number of Honorary Members	2
Total number of Active Members	238

CALL FOR MEETING.

NEW ENGLAND COTTON MANUFACTURERS' ASSOCIATION,
BOSTON, April 10, 1883.

DEAR SIR, — The stated annual meeting of the Association will be held at the Massachusetts Institute of Technology, Boylston Street, Boston, on Wednesday, April 25, 1883, at ten o'clock A.M., for the choice of Officers for the ensuing year, and the transaction of such other business as may properly come before it.

An afternoon session will be held, beginning at two o'clock.

The Board of Government propose the following subjects for discussion: —

FIRST. — DOUBLE ROVING AND HIGH DRAUGHT *VERSUS* SINGLE ROVING AND MEDIUM OR LOW DRAUGHT.

SECOND. — MULE-SPINNING FOR FILLING.

THIRD. — ELECTRIC LIGHTING IN MILLS.

By request of the Board, the first subject named will be opened for discussion by Mr. E. R. HANDY of Manville, R.I.; and other speakers have been invited to take part upon this and the other topics proposed.

The Board strongly urges that members familiar with the subject shall give to the Association the benefit of their experience.

By direction of the Board of Government.

AMBROSE EASTMAN,
Secretary.

The Secretary will receive nominations for membership until April 18, to be laid before the Board at its adjourned meeting, to be held at the Institute at 9.45 A.M. on the morning of the meeting.

PROCEEDINGS.

PURSUANT to the foregoing notice, the annual meeting of the New England Cotton Manufacturers' Association was held at the Massachusetts Institute of Technology, April 25, 1883, at half-past ten o'clock A.M., the meeting being largely attended.

The President, Mr. JOHN KILBURN, occupied the chair, and called the meeting to order, and requested the Secretary to read the call for the meeting.

The call was read.

The PRESIDENT. The next business will be the reading of the record of the last meeting. It has been customary to omit the reading of the record unless some objection has been raised; and, if there is no objection, we will omit it this morning. No objection being made, the reading of the record will then be omitted. The next business in order will be the election of officers for the ensuing year. It has been the custom heretofore to appoint a committee to nominate a list of officers, either by the Chair or from the floor. How shall we proceed at this time?

On motion, it was voted that the Chair appoint a committee of three to nominate officers; and the Chair appointed Messrs. C. D. McDUFFIE, H. F. WEST, and J. G. COBURN.

The PRESIDENT. Before this committee retires, I desire to say a word; and that is, that I believe that a change of officers in our Association, after a stated period of service, is desirable. I have been a member of the Board of Government for twelve years, I think, and for the last two years the presiding officer; and I tender my thanks for the honor that has been conferred upon me in electing me so many times. Therefore I desire to say to the committee before it retires, I cannot allow my name to be used again, believing it for the best interest of the Association that I should retire, and give some other person a chance to present facts for the consideration of the Association.

While the committee are out, it will be in order for the Treasurer to read his report.

The reports of the TREASURER, SECRETARY, and AUDITOR were then presented.

On motion of Mr. Draper, the reports were adopted and ordered placed on file.

The PRESIDENT. The next business will be to consider the recommendation to our Board of Government as to new members. The Secretary will read the list of applications and recommendations.

The following list of applicants was read; and, by vote on each name singly, they were admitted to membership in the Association: —

EDWARD S. ANTHONY	*Fall River, Mass.*
HENRY S. BARTLETT	*Providence, R.I.*
D. W. BLIVEN	*Uncasville, Conn.*
E. C. BUCKLIN	*Providence, R.I.*
FRANK FRIES	*Salem, N.C.*
WILLIAM B. GAMBRILL	*Baltimore, Md.*
JAMES GARY	*Baltimore, Md.*
ALFRED M. GOODALE	*Amesbury, Mass.*
ARCHIBALD M. GRAHAM	*Gloucester, N.J.*
FRANK HASKELL	*Saccarappa, Me.*
ELISHA H. HOWARD	*Harrisville, R.I.*
JOHN HOPKINSON	*Wesson, Miss.*
HOWARD RICHMOND	*Providence, R.I.*
GILBERT P. WHITMAN	*Manchester, N.H.*
WILLIAM R. WOOD	*Portland, Me.*

The SECRETARY stated that Mr. William H. Thompson of Salem, Mass., asked leave to withdraw from the Association; and by vote his request was granted.

At this point Mr. McDUFFIE of the nominating committee returned, and stated that the committee were unanimous in requesting that there be three or five gentlemen added to the committee.

It was then moved, in order that the committee should not consist of an even number, that four be added to it by appointment of the Chair, which motion was adopted; and the Chair appointed Messrs. CHARLES NOURSE, HERVEY KENT, GEORGE DRAPER, and R. B. BORDEN.

The PRESIDENT. While the Committee on Nominations are

deliberating over two or three points, we will take up the subject assigned for discussion this morning, and allow them to report at a later stage. The subject before us at this time is "DOUBLE ROVING AND HIGH DRAUGHT *VERSUS* SINGLE ROVING, AND MEDIUM OR LOW DRAUGHT." Mr. E. R. HANDY of Manville, R.I., will bring the matter before us.

DOUBLE ROVING AND LONG DRAUGHT *VERSUS* SINGLE ROVING AND LOW DRAUGHT.

BY MR. E. R. HANDY.

ONE of the subjects that we are to talk about this afternoon is single roving and low or medium draught, or double roving and high or long draught. Or, in other words, is it better to spin yarn on a spinning frame or mule, with a single roving and a roller draught that will not exceed say seven to one? or is it better to use double roving and a roller draught of say fourteen to one?

Now, gentlemen, from which of the two different processes can we get best results? which way will run better on the frame or mule, which way will produce yarn that is stronger and more even, and is better prepared to get the highest results in the weave-room, both in production and quality?

For, while we think the production of any weave-room does not depend by any means altogether on the strength and quality of the yarns used, we do think that it is a very important item to manufacturers that the strength and quality of the yarns shall be of the very highest degree possible; and we believe ourselves, and we do not think we stand alone in this belief, that yarns made from double roving and high or long draught are far superior both in strength and evenness than it is possible for yarns to be that are made from single roving and low or medium draught; that also the yarns made in this way are not only stronger and evener, but we are enabled to get a much larger production per spindle than we can by using single roving and low draught, providing the same quality of stock is used in both cases.

But I hear some one say that the idea is unreasonable, that better yarn can be made with a roller draught of fourteen to one, when every one knows that high draughts on any machine in a cotton mill is a disadvantage, and is something that we always ought to aim to keep down as low as possible. Very true this is, and is just what we believe ourselves; but it does not prove by any means that better yarn can be made with single roving and low or medium draught, than can be made with double roving and high or long draught. And our reason for believing such to be the case is this, —

Some twelve years ago we first began experiments with double roving and long draught, and the circumstances that led us to make these experiments were, that knowing double roving was used in many places where fine numbers of yarn were made, but always with a roller draught that would not exceed a draught that would be used if the roving was used single, and also knowing that the yarn made in this way was far better than yarn made by using single roving and low draught, and that the difference was very nearly as two is to one, we then thought, that, if the yarn made with double roving and low draught was so much better than yarn made with single roving and low draught on fine numbers, would not yarn made with double roving and high draught on coarse numbers be much better than yarn made with single roving and low draught? or would the good results obtained by using double roving and low draught be entirely destroyed by using a much higher draught than ever before on double roving in spinning coarse numbers? There was no way to find this but to try it, and this we did.

We were spinning then on frames No. 40 warp, using single roving and a roller draught of $7\frac{40}{100}$. We at once doubled this roving, and also doubled the draught; and the yarn thus made was, of course, the same as that made when using single roving and a roller draught of $7\frac{40}{100}$. But we also found that yarn made in this way, with double roving and double draught, was fully twenty per cent stronger, and a great deal evener than the yarn made with single roving in the old way, — in fact, so much so, that we were enabled to run with three turns less twist than we did on single roving, and still make yarn that was fully twenty per cent stronger and evener than yarn made as before.

Fully convinced now that we were right in our idea, we went still further, and doubled the roving and roller draught on every spinning frame and mule that we had in the mills. And in every case we got the same improvement over single roving and low draught as we did when we first doubled on the spinning frames, and are running to-day the following roller draughts with double roving: No. 68 mule-filling roller, draught $13\frac{50}{100}$, twist per inch 33; No. 45 warp, draught 14 to 1, twist per inch 28; No. 45 filling, draught $19\frac{5}{100}$, twist per inch 22; No. 33 warp, draught 16 to 1, twist per inch 23; No. 29 filling, draught $13\frac{57}{100}$, twist per inch 16. We also have drawn on the frame with double roving from $13\frac{42}{100}$ to $26\frac{88}{100}$, using in all

cases a hank roving that would give with each successive draught No. 28 warp, and found that this number yarn made with a roller draught of 26.88, $22\frac{55}{100}$ twist per inch, broke at seventy-two pounds to the skein. Kind of cotton used was what is called "strict good ordinary."

But, gentlemen, as we remarked before, we do not think that high roller draughts are by any means something to be aimed after in a cotton mill. On the other hand, we believe that better No. 28 yarn can be made with double roving and a roller draught of say seven to one, than can be made with double roving and a roller draught of fourteen to one. But, in order that we may be able to run this low draught of seven to one with double roving, we would be obliged to use a hank roving that would be as fine again as what we use with a draught of fourteen to one, and using double roving.

Now, would the results thus obtained by using a draught of seven to one, double roving, — would yarn made in this way be such a great improvement over the yarn made with a draught of fourteen to one? Would we get as much improvement as we did with double roving and high draught, that we should think it better to make a hank roving that would be fine enough so as to allow us to use a draught of seven to one, double roving, making No. 28 yarn? We do not think that we would. For, in the first place, how shall we get such fine roving in mills where they are making No. 28 yarn? Shall we make it finer in the card-room? How? By using more roller draughts all around is one way.

But, gentlemen, we think that there is draught enough now, and in some cases altogether too much, where they are making hank roving for No. 28 yarn, and drawing single.

But you say we might put more machinery in the carding-room, so as to allow us to make a hank roving fine enough, in order that we may use a low draught and double roving. But can we afford to use this machinery, which would greatly increase the cost of manufacturing No. 28 yarn. Unless the price of cotton goods should be very much higher than they are to-day, we think that the cost of manufacturing cotton yarns ought to be decreased, instead of increased.

On the other hand, does it cost any more to spin No. 28 yarn, with double roving and high draught, than it does with single roving and low draught? On the contrary, it costs less: for

the yarn is so much improved by this method, that we are enabled to get a much larger production on the frame or mule than we can when using single roving and low draught; and the greater the production per spindle, the less it costs for labor and every thing else in the manufacture of cotton yarns. Furthermore, we do not use any other machinery by using double roving and high draught than we do when using single roving and low draught.

But some of you may say that this talk is all very well. If a man has what is called a hobby, he will prove that it is all right, — at least he will make himself think so. I have tried it; I know what it is. I cannot get any twenty per cent improvement. If it is such a good thing, it ought to show for itself.

It does, gentlemen, and in more places than one. Because some people are unable to run a Corliss engine so as to get such high results as others do, does it prove that Corliss does not build a good engine? We believe that the fault lies, not with the builder of the engine, but with those who are running it, and the same with double roving and long draught. We hear of some who have tried it and cannot see any improvement. Yes, they have tried it; and how did they do it? In many cases — and we know this for a fact — they have changed one frame, and run it half a day, or just long enough to get a size, and break the yarn, and find that it did not break any stronger than before; and we should not think that it would. We think for a good illustration of double roving and high draught, what it can do and is doing, we need look no farther than the filling frame; for we claim that double roving and high draught has been one of the principal means by which the filling frame has been made a success, and we are enabled to successfully compete with the mule in spinning filling; and we fully believe, that, if you should take away double roving and high draught, on a great many filling frames where they are now using it, they would have some difficulty in spinning yarn that could be called filling. Why, gentlemen, we understand it is claimed by some that they get fully forty per cent improvement on their filling frames in quality and production by using double roving and long draught. Forty per cent improvement! How did those filling frames run before they doubled the roving and draught? We believe that some of them were unable to run at all at any profit.

But it is said that it is impossible to get such a large improvement by using double roving and long draught; that the results obtained are so small that it would hardly pay to change the creels and the draught-gears on the frame or mule. We would say in reply to this, that, where an improvement can be made in a cotton mill with so little expense as this requires, the percentage of improvement would have to be very low indeed, so that it would not pay to change; and we believe that this percentage has never been reached by using double roving and high draught. In conclusion, we would say that there are probably gentlemen here to-day who are as well qualified (if not better) to speak on this subject as we are, and we should be pleased to hear from them.

Mr. Handy's paper was attentively listened to, and at its conclusion hearty applause was given. The Committee on Nominations, being now prepared to report, did so as follows: —

Mr. McDuffie. In making the report of the committee, I will say the committee took into consideration the question of making a change, in order to introduce new elements by presenting new men for officers: hence we have made up the list we have with a desire to give you the best talent possible, which is as follows: —

For *President*, William C. Lovering.

For *Vice-Presidents*, Richard Garsed and J. S. Ludlam.

For *Directors*, John W. Danielson, Walter E. Parker, R. A. Maxfield, George W. Weeks, Henry S. Howe, and R. B. Borden.

The report of the committee was accepted; and on motion it was voted to authorize Mr. Hervey Kent to cast a single ballot for the above names in behalf of the Association, and they were declared elected to the several offices for which they had been nominated.

Mr. Lovering then proceeded to the President's chair, and said, —

President Lovering. Gentlemen of the New England Cotton Manufacturers' Association, I hardly know how to assume the duties of this office. It is entirely unexpected, and I was struck almost dumb when my name was read, or I think I should have declined to have it presented; but, as I understand by the report of your committee, an effort is being made to secure rotation in office; and, as possibly a brief term of service may see me through with its arduous duties, I most gratefully, though hesitatingly, accept the honorable position. Thanking you for your kindness, and bespeaking your indulgent consideration for all errors, I will endeavor to perform the duties of the office with faithfulness and such ability as I have. [Applause.]

Gentlemen, the meeting is now open to proceed with the discussion of the question before us, — the question of double roving and high draught *v.* single roving and medium or low draught. You have already heard the paper read by Mr. Handy, and you are invited to participate in the discussion. The Chair

awaits any remarks upon the subject. [A pause ensued, no one volunteering to open the discussion, and the PRESIDENT said] There are doubtless many men here competent to speak upon this subject, who have diverse opinions with regard to it. I presume it is a natural bashfulness on the part of a great many that prevents them from commencing at once. [At this point Mr. Draper arose to remove an outer coat, and the PRESIDENT neatly got him to begin the discussion by remarking] Mr. Draper is up, and I will call upon him. [Laughter.]

Mr. GEORGE DRAPER. Gentlemen, you notice it is dangerous to get up to pull your coat off.

A MEMBER. It is supposed, when a man pulls his coat off, he means business.

Mr. DRAPER. Gentlemen, I am somewhat unfortunate in not having heard the paper read to enable me to go on, and make remarks that will be pertinent to what has been presented. There is no question, as I understand it, among manufacturers as to whether we shall have double or single roving for fine work, such as yarn for thread and the finer kind of yarn. I believe the practice is universal, when anybody wants to make a nice fine thread, to use double roving for that purpose. The question how much draught you should give that double roving is, I suppose, the question before you here; that is to say, how much draught you better give it to be profitable. I have paid a good deal of attention to this matter, and have had men working for me under instructions to be exceedingly careful in their experiments, with the intention and endeavor to know the truth, and only the truth, in regard to it. I have had more experiments tried on about No. 36 yarn than any other; and our experiments have been confined more to filling than to warp. And I have no hesitation in saying, that, if the parties who have been employed by me to experiment in that line have made their experiments with care, and have reported to me correctly, there is no question about the matter, none whatever; with roving that would require a draught of, we will say, eight or nine single, put into a frame suitable for it to spin No. 36 filling, and then put in two rovings and give it a double draught. There is no question but that it spins better; that is to say, less ends break in spinning, other circumstances being the same, and there is a greater strength of yarn. If I am not to believe that, I must believe that when I take pains to ascer-

tain a fact, and take considerable pains, because it has not been done in any one mill, nor in any one day, nor at any one time, nor by any one person, but it has been done in different mills, at different times, and by different persons, the result is not to be relied upon. But that is the result which has been reported to me as correct, and I believe it to be correct. That is to say, you want to spin No. 36 filling from roving already made. You could do it to far better advantage to give it a draught of fourteen, and use it double, than you could to give it a draught of seven and use it single; and I believe that pertains also more or less to warp yarn. I believe the fact of having two separate, independent slivers to be twisted together at that lowest point of work, gives the yarn a greater strength, and it works better even with this extended draught than it does to use it single; that is to say, the doubling at that point does more good than the extra draught does harm, and I notice that in all these cases, if you make it in that way, you untwist it, and it retwists itself in two independent structures. It is in the nature of twisting two made threads together to a greater or less extent. I am not disposed to make any argument, or go into this matter at any great length; but I think, gentlemen, that the true meaning of our meeting here together is to learn facts in regard to the business we are engaged in, and recognize facts, and to endeavor to improve from time to time by ascertaining facts, and applying them to use in our business.

Mr. Coburn. Mr. Chairman, I would like to make a query of Mr. Draper while he is on the floor, if he will allow me to. He has made a statement as to certain trials the conclusion of which he has stated. I simply want to inquire whether, in the cases to which he referred, which underlie this judgment of his, the difference in draught was made as between the front and middle roll, or whether it was distributed in the frame, only an increase between the first and second.

Mr. Draper. It is only an increase between the first and second. We have tested it by using the same roving and filling upon the frame with double draught, and on another frame with single draught, and counting the ends that broke down on the different frames for quite a long period of time on each frame, by testing the strength of the yarn to ascertain which was strongest.

Mr. Coburn. The only point was to get at the circumstances under which you had reached the fact.

Mr. PRAY. I would like to ask a question. I am sure the point will come up here directly; and that is, whether the elasticity of the yarn with an increase of twenty per cent in the strength has been increased or diminished. I ask the question for information.

Mr. DRAPER. I do not think I am able to answer that question exactly, and have not taken that matter into consideration in the experiments which we have tried.

Mr. JOHN KILBURN. I wish, Mr. Chairman and gentlemen, to say a word or two as to the result of my own experience in this matter of double roving. I have had no test of double draught; but there is no question about the increased evenness of yarn made upon two slivers of roving rather than one. The difference in the strength is very material. The difference in the evenness of the yarn is quite marked; and I believe, without saying any thing on the question of double draught, that you can safely calculate upon an increase of twenty-five per cent in the strength of the yarn made from double roving rather than from single roving. I think the elasticity is less, although I have not tested that matter; but, from the nature of the thing, I have found by untwisting yarn that one sliver of the roving was twisted around the other, and it produces an effect similar in some respects to twisting two threads together for the purpose of thread-making. I know cases where changes have been made whereby the cost of producing yarn has been considerably increased by the addition of machinery and labor, but the weaving has been reduced fully twenty-five per cent. I am a strong believer in double roving. I am yet to be convinced in respect to double draught; but I have been very much interested in the paper read before us this morning, and I hope to be further enlightened in relation to it. I would like to hear from Mr. Danielson. I see he is present.

The PRESIDENT. Will Mr. Danielson favor us?

Mr. DANIELSON. Mr. President, I do not think I can give any information. I am surprised that Mr. Kilburn should call upon me. We have tried the experiment in a small way, and have seen benefit from it; but I am not able to give any figures at this time.

Mr. KILBURN. I was induced to call upon Mr. Danielson because I understood that he and Mr. Lockwood had been experimenting in this direction; and I have also been told, by

a member of the Association present, that the Lockwood Company of Waterville, Me., are running their entire mills upon this system. Being one of the treasurers of that company I thought he would know about it.

Mr. CHARLES NOURSE. Mr. Chairman, a gentleman present has made some tests in regard to strength and draught, although he is not a member of the Association. I would move you that we extend an invitation to the gentleman to speak. I refer to Mr. Charles E. Thomas of Woonsocket, R.I. [The motion was adopted, and Mr. Thomas was requested to address the meeting.]

Mr. THOMAS. At the Clinton Mill, Woonsocket, we recently changed a filling frame of 128 spindles from single to double roving, and its draught from 8.67 to 17.34 to make the same number of yarn as before.

The frames were operated with the Draper evener. The number of yarn desired was No. 31.50.

The experiment, of which I have the data, was continued for twenty-nine working days. We took four leas each day from each of the frames.

Of the one hundred and sixteen leas broken of each kind, we found that eighty leas of each broke within a number each way from the number required. The remaining thirty-six were so few of any one number, that, considering them valueless comparatively to base any thing upon, I have not entered them here.

The eighty leas of each broke as follows: —

SINGLE.			
LEAS.	GRAINS.	NO. YARN.	LBS. BREAKAGE.
15	31	32.26	43
3	31.50	31.75	48.33
41	32	31.25	44.90
5	32.50	30.77	47.80
16	33	30.31	49 37
80	32	31.25	45.75

DOUBLE.				PER CENT.	
LEAS.	GRAINS.	NO. YARN.	LBS. BR'KAGE.	GAIN.	LOSS.
16	31	32.26	46.12	.073	
5	31.50	31.75	43.80		.094
36	32	31.25	48.37	.077	
3	32.50	30.77	52.33	.095	
20	33	30.31	52.30	.059	
80	32	31.25	48.76	.066	

I may mention, that, of the thirty-six leas not given above, the finer the yarn the greater proportionate strength of the double; and the opposite seemed the case when coarser.

I kept an account for two and one-half days of the number of ends that broke down while running, though I think with Mr. Handy it is not long enough to be conclusive. As I have it here I will give the result: —

	SINGLE.	DOUBLE.
First half day	35	33
Two days	144	139
	179	172

Mr. H. F. Lippitt. Mr. Chairman, it seems as though everybody should bring what he can to the discussion of this subject; and, as some gentlemen have given their experiments, I thought I would tell what we have done at the Globe Mills in Woonsocket. Two years ago this matter was brought up before this body, and was discussed by Mr. Draper and others; and, in consequence of what was said then, we determined to make an experiment, and see what the result would be. We had filling frames that were spinning No. 35½ filling, running single roving with a draught of 7.31, five-hank roving. We took one frame,

and fitted it for the double roving to spin the same number, making the draught 14.62. In other respects it was exactly the same. We then had the number of ends that were broken down on that frame carefully kept, and took two frames, one on each side, which were spinning with the single roving, and kept the number of ends that were broken on these frames in comparison with the other. We run the frames in that way for fifteen doffs. I had four bobbins from each frame broken, each doff; which made fifteen times twelve bobbins for the total number of breakages. We found a very great advantage from double roving; and the advantage was so great that we changed over the filling spindles we had to double roving, and afterwards, when we put the filling spindles into the Social Mill, had them all fitted to run double roving. I will give you what we got from our experiments on one of the frames which ran single roving. This is the average result of the whole number of breakages. On one frame, single roving, the number was 35.88, the pounds 32¾, and 103 ends broke; on the second single roving frame, the number, 35.73, the pounds 35¼, the number of ends were 85. On the double roving, the number was 35.52, the strength was 39.6½, and the number of ends broken was but 58½, which made a difference in breaking strength of sixteen per cent, in the number of ends that were broken down of forty-two per cent, and in the waste (we also kept an account of that) of thirty-two per cent. Afterwards we allowed the frame to run in that way some little time before we changed the whole of them, but finally made another test to be sure we were correct; and at that time we got twenty-two per cent increase in strength for the double roving and thirty-nine per cent less ends broken down. We then attempted to see what we could do on the warp in the same direction, and we made experiments which were conducted exactly the same way on the warp; but we never gained such large results from the double roving on the warp as on the filling. The gain we found to be about six per cent, and the experiments were repeated three times. The per cent gained varied very little from that each time. We also tried the experiment on the mules to see whether we would get such a difference there. We found the gain in strength was equally great with the gain in the strength on the frame filling; but I was never able to make the mule run as well with the double roving as with the single roving. We kept account

of the number of ends broken for nine different times for two hours at a time, and several times the single roving had less than half the total number of ends down that there was on the double roving; but we finally took a little twist out of the mule which had the double roving, and that made a great difference in the running. It ran very much better then than it did as it was first started. When we first started it, we ran it exactly the same as the other mules. The final result was a great increase in strength; and the number of ends broken down was about the same when there was one turn less twist in the double roving than in the single; but the number of ends that were broken down did not include the roving breaking back, and that was a very important item on the mules, because we had but very little space to spare on the creels. We were therefore very much troubled with the roving breaking back, and on that account have never changed our mules, nor have we changed our warp-frames, although we thought of it once or twice, and I think undoubtedly it would be a good thing. Six per cent is not as much as forty, but it is considerable. I would not think of running a filling frame without double roving. I think a single draught is much better than a double draught. A draught of seven to nine is much better than a draught of fourteen to twenty; but I think the double draught and double roving on a filling frame is far better than a single draught and single roving.

Mr. George Draper. I would confirm, for I think it is important, the statement made by Mr. Lippitt in regard to the twist. We uniformly found that, when we had the roving double, it needed less twist. It is on the same principle, that, when you come to twist yarn together, you want it sponge-like, in the first place, in order to twist well; and it seems to me the nature of this thing, as I said, is like twisting two fine threads together. Another matter in regard to it, which you will see is a very important matter. Nobody, I suppose, would contend that four-hank roving of the usual character with a double draught having twenty would be any better than it would fourteen. It may not be as good as it would at twelve possibly. I do not say that it is not. That is a question for gentlemen to try. But the thing that comes in here is that it costs you more to make roving finer. We want to get the results, if we can, at the lowest cost; and, if when you have got your roving made four-hank roving, it will

stand a double draught, and answer your purpose very well, carrying it up to sixteen or thereabouts, why, then, you do not want to make your roving any finer, because it will cost you more money. That is where the point comes in. The question is practically to settle, when you have made your roving double, or made up your mind that it is an object to use it double, to what extent you will carry it, or how fine you will make your roving. I am satisfied myself, so far as I have observed, that in making filling yarn the gain is very great. I have not any doubt about it, and in making warp yarn I believe there is a material gain. The gentleman speaks of six per cent. There have been times along back when we have been very glad to loan money and get six per cent on it, and I do not know why we should not be glad to get six per cent on our improvements in machinery. [Applause.]

Mr. Danielson. Mr. Chairman, I feel that perhaps some explanation should be made in regard to the Lockwood Company at Waterville, as Mr. Kilburn has referred to that mill. It is true that the Lockwood Company are using double roving in their new mill, but they are not using the double draught. In the No. 1 mill the draught on the warp is about seven; in the No. 2 mill, where the double roving is used, the draught is about twelve, increasing the draught, as you see, about seventy per cent. When I was up before, I remarked I could not give any results, because we are not using single roving for the same numbers of yarn we are making with the double roving. That the work is very satisfactory, is the most I can say in regard to it. I am satisfied of one thing, that, if you have poor roving, you get better results with double roving; or to make the matter a little clearer, perhaps, if you could have perfect roving and perfect spinning, you would not get any great advantage by doubling your roving. But the difficulty is that we do not always get perfect roving, and by doubling it I have no doubt we get a better result in the evenness of the yarn; and that is where the strength comes in, the evenness of the yarn.

Mr. C. I. Barker. Since this matter of double roving and double draught has been discussed before the Association, I have made some few experiments in that direction. Not having the figures with me to-day, I did not think I would say any thing about it; but for general information I will give you what my experience has been in that direction. On No. 30, where we used seven

draught, I put in double roving, and made the draught fourteen and a fraction, in order to produce the same number of yarn. I ran two frames for a week side by side, and kept account of the breakage, and also tested the yarn each day, seven bobbins from each frame; and I did not find any difference. I did not find that the double roving and double draught were any better. I did not find that it would stand any more, and, from my recollection now, it was not quite so much as it was from single roving. Hence, as far as the question of double roving goes and medium draught, I have no question at all in my mind but that would make the best yarn. In fact, I know it, because we have tested it repeatedly at our place. But as to double roving and double draught, using, in place of seven, fourteen and a fraction, to produce the same number, I should want considerably more information and light upon the subject and evidence before I could be convinced that this would be advantageous to the manufacturer.

A MEMBER. I should like to ask the gentleman whether it was filling or warp?

Mr. BARKER. Warp, sir.

A MEMBER. Did it require more or less draught to produce the same number?

Mr. BARKER. More.

A MEMBER. Then the result covered the same number?

Mr. BARKER. The same number at different times.

Mr. CHALES NOURSE. Mr. Chairman, I would like Mr. Stiles, of the Victoria Mills of Newburyport, to be called upon.

Mr. STILES. Mr. Chairman, believing in the saying of the little boy, "You'd scarce expect one of my age to speak in public on the stage," I did not bring any figures with me; but about a year and a half ago it was suggested to us to change one of our filling frames to double roving and double draught. I said to the gentleman who suggested it, not speaking very creditably to his intelligence, "Go ahead." I told him the idea was preposterous, that we could make as good yarn with fourteen and a half draught as with seven and a fourth. They went and made the change, and we assisted him in making the change; and they kept account, as has been stated here. We took out one tooth of twist making No. 29½ yarn. The yarn was fully twenty per cent stronger, which of course means so much evener. It was so much better, that, after running it two months,

I ordered the whole of our filling frames changed. We added twenty per cent to the amount of work done by each girl; and, as they claim they do not work so hard by twenty-five per cent to do twenty per cent more work, we must be getting very much evener yarn to make it so much stronger. We are getting a larger production. I presume we are running our frames as fast as any in the country. Our numbers average 26½. We have three numbers of yarn, 19 and a fraction, 25, and 29. On our 19½ yarn we run a hundred and forty-two turns on the front roll. Each girl tends about six hundred spindles, and gets ninety cents a day. We are spinning on the average 26½ for about one cent per pound in the spinning room, costing us a fraction above half a cent per pound in cloth. On our 25 yarn we run a hundred and thirty turn on the front roll. Each girl tends on that six hundred and seventy spindles for about ninety cents a day. If any one had asked me a year and a half ago, and I did not know what I know now, if fourteen draught was better than seven, I should have said, "No." And the opinion seems to be entertained by some now. But the facts are before us, and they are hard things to contend against. Our girls can run twenty per cent more work, and produce twenty per cent stronger yarn, with a draught of fourteen and a fourth, if you double the roving. Yet it is hard for us to say we believe in fourteen draught instead of seven. If any gentlemen are desirous of further information than I can give, I should be pleased to see them at the Victoria Mills, and will, with great pleasure, show them our spinning frames.

A Member. I would like to ask Mr. Stiles how much larger production is the loom yielding than before?

Mr. Stiles. For the same reason, that I did not expect to be called upon, I cannot give the gentleman the information he desires; but it will be a very easy matter to figure it up, and send it to the Association, or to any gentleman who will give me his address.

Mr. Kilburn. I would like to hear from Mr. Greene, of the Cabot Manufacturing Company.

Mr. Greene. Mr. President, I never have had any experience in double roving or double draught; nor did I ever expect to live to see the day that, if the roving was ruined in the card-room, we could fix it afterwards. [Laughter.] But I do not know but we can. It used to be considered, when the work

was spoiled in the card-room, it was spoiled beyond remedy; but, if this double roving and double draught is going to correct it, we shall have to accept it.

Mr. DANIELSON. If I understand Mr. Draper correctly, he gets better results from double roving in spinning filling on frames, I suppose he means, than in spinning warp; and I would like to know why.

Mr. DRAPER. I think I might have stated that, and I think I could say what the reason is. The fact was brought out before I spoke here, that they found it was necessary to reduce the twist when they came to double the roving. And as we want to spin the filling with the lowest amount of twist, as a rule, that we can, and we are not so anxious to do it in the warp, I think that that is the true reason for it, that in spinning with the least possible twist we get the greater advantage. That leaves it more in the condition of the roving itself, without the element of twisting.

Mr. H. F. LIPPITT. When I was making the experiment I told you about I was very much puzzled by that same question which Mr. Danielson has asked; and I thought it over a great deal to see if I could find any explanation of it. I have come to the conclusion that it was due to the fact that fine places in a thread need more twist than coarse places to gain their maximum strength, just as fine yarn needs more twist than coarse yarn; and that, as properly made warp has all the twist it will take to advantage, it has enough for both the fine and coarse places. Filling, on the other hand, being made with as little twist as possible has no surplus, as in the case of the warp, to run into the fine places. In filling, probably, the fine places have no more twist than coarse places, while in warp they probably do; and therefore the strength of fine places in the warp is nearer the strength of coarse places in filling. The effect of doubling the roving is to take out the fine places, and to even the thread; and these places, in filling, being weaker in proportion to the strength of the coarse places than in warp, it follows that by taking them out of the filling you make a greater gain than by taking them out of the warp. The gain in the filling is greater than the gain in the warp, because the fine places in the filling are weaker in proportion to the average strength of the thread than the finer places in the warp; and they are weaker because the filling has no surplus of twist to run into strength there.

Mr. Brown. I would like to ask what is the draught on your fly-frame?

Mr. Lippitt. The draught is 6.66.

Mr. McArthur. I feel somewhat diffident about addressing an audience of this character. I presume there is hardly a member present who cannot express his views more clearly than it is possible for me to do. However, as I have been a member of the Association for the past twelve years, and have taken no active part in its discussions, it would seem that I am somewhat selfish in coming here from year to year, getting what information I can, and keeping what little I might give. Therefore I will tell you my experience with double roving as far as it goes. Some fifteen years ago I was employed as overseer of the warp-spinning in the Manville Company's mills at Manville, R.I. Mr. Russell Handy was then and is now manager. Mr. Handy, as we all know, is a man of practical ability; and, as I have had some little practical turn of mind myself, we often exchanged views in relation to this matter of double roving and high drafts. We finally concluded to change one frame from single to double roving, and we found the results very gratifying indeed. We run the frame several weeks without making any further changes, watching it carefully, and comparing the quality of the yarn with that spun in single roving. We had no machine for testing the strength of the yarn. The only substitute for trying its strength and elasticity was in the old-fashioned way by drawing about a yard from the bobbin and stretching it out between the hands, a way of testing the yarn that was common with spinners. We also kept a strict account of the number of threads that broke down in the frame, and compared them with those that broke in the adjoining frame, — the result of which was strikingly in favor of the double roving. I am sorry that I am unable to give you the figures of the test which we made at that time, having mislaid them. We decided to change half of our frames on to the double roving. When this had been completed, we had hardly ceased congratulating ourselves when we had trouble from another point.

The spinners on the lower half of the room became dissatisfied, claiming that the help who were on the double roving could tend more spindles, earn more money, and work easier; and said that they ought to be paid more per side, or have an

opportunity to work on the same kind of work. We then concluded that it would be best to change all of the frames on to the double roving. I remained in charge of the room about a year after making the change; and I am free to say, from all my experience as a spinner from a boy up to the present time, I never saw a better running room of spinning than we had there. We did not run the spindles at as high speed as most of mills run now: they ran about six thousand revolutions per minute, and the draught in the rolls was about 14 to 1.

About ten years ago I was engaged to take charge of the Manchaug Mills. The new mill No 3 was built and equipped for making fine work, and they were then changing the warp-frames from No. 50 to No. 28; and were also changing roving in the frames from double to single. To this I objected, and we decided to stop where we were.

They had changed some twenty-eight or thirty frames, which represented about one-third of the spindles in the room. I told our treasurer that I could convince him that it would be better for us to continue to run the roving double, even at the expense of a high increase in draught. We took one frame, changing one side on to double roving, and the other side run with single; both sides working the same hank roving, and making as near as possible the same number of yarn. We run the frame thirty days, sizing and breaking the yarn from each side every day; and in all of that time there was not one instance that the yarn from the single roving broke as strong as that which was spun from the double.

That may seem strange, but there was not one single exception in the whole thirty days' trial. We then changed all the frames back again on to double roving. I would say that in this mill we have four operations of speeders. Therefore it would not be fair to compare the yarn produced from it with what has been said here to-day in relation to double roving and high draught. But in our No. 2 mill, so called, we have only three operations on speeders. The warp-spinning in this mill was changed from single to double roving some four or five year ago, and from this we have made a number of tests. I will give you the results of two or three that we made quite recently. The first that I will read is a test that was made for six consecutive days. The speed of the front roll in the single was ninety-six revolutions, in the double one hundred and five

revolutions, — an increase of 9.37 per cent. Twist per inch on the single 25.47, and the double 23.25, — a difference of 9.55 per cent. Draught between the back and middle rolls in the single 1.027, in the double 1.001, — 1.58 per cent less in the double. I will say here, that, if Mr. Barker retained the same

No. 1.

Warp-Spinning Department, Manchaug Mills. — Test of Double against Single Roving, made for Six Consecutive Days.

	Single Roving.	Double Roving.	Percentage.
Speed of Front Roll . .	96	105	$9\frac{37}{100}$% faster.
Twist per Inch	$25\frac{47}{100}$	$23\frac{25}{100}$	$9\frac{55}{100}$% less.
Draught bet'n B. & M. R.	$1\frac{27}{1000}$	$1\frac{11}{1000}$	$1\frac{58}{100}$% "
" " M. & F. R.	$7\frac{27}{100}$	$14\frac{77}{100}$	$103\frac{16}{100}$% more.
Total Draught	$7\frac{46}{100}$	$14\frac{93}{100}$	100% "
Average No. of Yarn . .	$27\frac{21}{100}$	$28\frac{17}{100}$	$3\frac{52}{100}$% finer.
" Breaking-Weight,	55 lbs.	57 lbs.	$3\frac{63}{100}$% stronger.
" Strongest Thread,	59 "	60 "	$1\frac{69}{100}$% "
" Weakest " .	51 "	54 "	$5\frac{88}{100}$% "
Extremes	48-61=13 lbs.	52-62=10 lbs.	30% evener.

No. 2.

Warp-Spinning Department, Manchaug Mills. — Test of Double against Single Roving, made for Six Consecutive Days.

	Single Roving.	Double Roving.	Percentage.
Speed of Front Roll . .	96	105	$9\frac{37}{100}$% faster.
Twist per Inch	$25\frac{47}{100}$	$23\frac{45}{100}$	$9\frac{55}{100}$% less.
Draught bet'n B. & M. R.	$1\frac{27}{1000}$	$1\frac{11}{1000}$	$1\frac{58}{100}$% "
" " M. & F. R.	$7\frac{27}{100}$	$14\frac{77}{100}$	$103\frac{16}{100}$% more.
Total Draught	$7\frac{46}{100}$	$14\frac{93}{100}$	100% "
Average No. of Yarn . .	$27\frac{13}{100}$	$27\frac{88}{100}$	$2\frac{76}{100}$% finer.
" Breaking-Weight,	55 lbs.	56 lbs.	$1\frac{82}{100}$% stronger.
" Strongest Thread,	59 "	$59\frac{2}{3}$"	$1\frac{13}{100}$% "
" Weakest " .	$51\frac{1}{3}$"	53 "	$3\frac{25}{100}$% "
Extremes	48-61=13 lbs.	50-61=11 lbs.	$18\frac{18}{100}$% evener.

No. 3.

Warp-Spinning Department, Manchaug Mills. — Test of Double against Single Roving, made for Six Consecutive Days.

	Single Roving.	Double Roving.	Percentage.
Speed of Front Roll . .	96	101	$5\frac{21}{100}$% faster.
Twist per Inch	$25\frac{47}{100}$	$44\frac{40}{100}$	$4\frac{39}{100}$% less.
Draught bet'n B. & M. R.	$1\frac{27}{1000}$	$1\frac{11}{1000}$	$1\frac{58}{100}$% "
" " M. & F. R.	$7\frac{27}{100}$	$14\frac{77}{100}$	$103\frac{16}{100}$% more.
Total Draught	$7\frac{46}{100}$	$14\frac{93}{100}$	100% "
Average No. of Yarn . .	$27\frac{2}{100}$	$28\frac{4}{100}$	$3\frac{77}{100}$% finer.
" Breaking-Weight,	$54\frac{3}{4}$ lbs.	$56\frac{1}{2}$ lbs.	$3\frac{12}{100}$% stronger.
" Strongest Thread,	$55\frac{3}{4}$ "	$57\frac{3}{4}$ "	$3\frac{58}{100}$% "
" Weakest " .	49 "	$52\frac{1}{4}$ "	$7\frac{32}{100}$% "
Extremes	49-61=12 lbs.	50–58=8 lbs	50% evener.

Average of Nos. 1 and 2.

	Single Roving.	Double Roving.	Percentage.
Average No. of Yarn . .	$27\frac{17}{100}$	$28\frac{72}{100}$	$3\frac{18}{100}$% finer.
" Breaking-Weight,	55 lbs.	$56\frac{1}{2}$ lbs.	$2\frac{73}{100}$% stronger.
" Strongest Thread,	59 "	$59\frac{5}{8}$ "	$1\frac{41}{100}$% "
" Weakest " .	$51\frac{1}{6}$ "	$53\frac{1}{2}$ "	$4\frac{56}{100}$% "
Extremes	48-61=13 lbs.	$51-61\frac{1}{2}=10\frac{1}{2}$ lbs.	$23\frac{81}{100}$% evener.

draught between his middle and back rolls, it was probably the reason why he was obliged to increase his total draught to a little more than double in order to get the same number of yarn. When you increase the draught of course you decrease the speed of the middle and back rolls; consequently there is not the same per centage of difference between the middle and back when compared with the high draught between the front and middle, but about half. Now, some might have the idea, that, if the total draught was the same in all the frames in a room working the same hank-roving, the yarn ought to be the same size or number. But this is not so; as I know that I can easily make a difference of two or three numbers, either coarser

or finer, with the same hank-roving and same total draught. My experience as a spinner leads me to believe that, if the rolls are properly weighted, the draught between the back and middle rolls does not amount to much. If the roving in frames that some spinners have was drawn as much between the back and middle rolls as the draught figures, it would make wretched poor yarn. But it does not do that, because the back rolls are weighted so lightly that they do not draw. It simply keeps the roving straight, and stretches it but a very little. Therefore, if you take a part of the draught from the back and middle rolls and place it in between the middle and front rolls, you really increase the draught of the frame in proportion. Any one can easily satisfy himself on this point if he chooses to try it. In one case we in reality more than double the draught, as you will notice in the report of our tests, which I will now continue to read.

The draught between the middle and front was 7.27 on the single, 14.77 on the double, — an increase of over 103 per cent. The average number of yarn for the six consecutive days was 27.21 on the single, and 28.17 on the double, — a percentage of 3.52 finer. You will notice that the double is nearly one number finer than the single, although they were both reeled from the same roving. I claim that this result is caused by the difference in draught between the back and middle rolls. The average breaking weight on the single was 55 pounds, on the double 57 pounds, — an increase of 3 63 per cent stronger. The average breaking weight of the strongest of the six reelings was 59 pounds on the single.

QUESTION. What was the number of your yarn?

Mr. McARTHUR. No. 28, or a little on the light side of that number. The average strength of the strongest on the double was 60 pounds, — an increase in favor of the double of 1.69 per cent. The average of the weakest threads in the six reelings was also taken, and was 51 pounds on the single, 54 pounds on the double, — an increase of 5.88 per cent in favor of the latter. The extremes, from the strongest to the weakest, were noted, and were from 48 to 61 pounds on the single, — a difference of 13 pounds; on the double they were from 52 to 62, a difference of 10 pounds, — giving us 30 per cent in favor of the double. I claim that this shows one of the main points in favor of the double roving. It proves clearly that the yarn is

more uniform in strength, which we must admit is a great advantage. I have with me a report of other tests, which were made at about the same time and in the same way. But I fear I am taking up too much of your time. I will give you the average of Nos. 1 and 2 of the tests we made, and will then give way.

The average number of yarn was 27.17 on the single, 28.02 on the double, — percentage 3.13 finer on the double. The breakage was 55 pounds on the single, and 56½ pounds on the double, — 2.73 per cent stronger. Strongest threads 59 pounds on the single, and 59.87 on the double, — an increase of 1.41 per cent. The weakest threads 51.12 on the single, and 53.50 on the double, — gain of 4.56 per cent in favor of the latter. The extremes from 48 to 61 pounds on the single, and 51 to 61½ on the double, — a difference of 13 pounds on the single, and 10½ pounds on the double, — a percentage of 23 81 in favor of the double; the total draught in each test being 7.46 on the single, and 14.93 on the double.

I have also another test made in the same way as those I have given, with the exception of a change of one tooth in the twist-gear, making the twist 4.39 per cent, instead of 9.55 as in the other two tests.

Mr. Greene. There is one thing, it seems to me, that has been overlooked here entirely. It is generally considered that the heavier we weight the roll, the more it injures the staple. Now, so far as I know from what I have heard, they use the same weight on their roll in double roving as they do in single. Now, if that is the case, it seems to me it would make a material difference in the strength of the yarn. It is really double weight for the single roving; that is, just as much weight as when used double.

[A conversation here ensued between gentlemen, which was inaudible to the reporter.]

Mr. H. F. Lippitt. In this case the gentleman is partially correct, I think; that is, under the back and middle rollers there is more cotton: but those rollers run very slowly. They run only half the speed that they do with the single draught. Under the front roller there is the same amount of cotton that there was in the case where you had the single roving. The strand there is exactly the same size, and has the same amount of cotton as the other.

Mr. BIRKENHEAD. In respect to the draught on the rolls, there is quite a difference between the English idea and the American idea. It seems to be universal in England, and has been for thirty years to my knowledge, to have the middle roll not weighted at all. So in this case I think that ought to be considered. Now, if they can run with the middle rolls not weighted at all, why do we weight rolls? Is there any advantage in it? There must be a right way some where, if some weight them and some do not weight them. I have tried experiments in that line, not sufficient to ascertain any determined facts about it; but I have tried it as far as this: I wanted to know what the limit was in having a roll the ordinary size without any weights in the middle; and, in order to test it, I put in wooden rolls, which weighed but a few pennyweights: they were about five-eighths of an inch in diameter, of black walnut, and I let them run. That was an extreme case, running the middle roll without any weight on it at all; and I think there was no difference. It is a hard thing to judge when there is any difference in yarn about thin places. I took the yarn that was spun in the frame where the middle roller run simply by its own weight, and put the yarn that was spun with the wooden roll alongside of that, and yarn from weighted rolls, and I could not make up my mind which looked to be the best yarn; but still, I think, if I had to give a preference, I should have preferred that which was run with the wooden roll, with no weight at all.

There is another question in regard to cotton-spinning. I do not know as I know much about it, it is so many years since I was an overseer; but I look back to the way the old lady used to do her spinning. What kind of rolls did she have? She did not have any great weight, but used her thumb and finger to regulate the size of the yarn; and, if there was any long fibre, there was so little weight put on it that that long fibre would draw out without any interruption. But we know if we put an enormous weight on the middle roll, and put light cotton in there, it is sure to break it. I think this roller question ought to be investigated, and I think that some good results may come from it. I simply mention this. As I said before, I have not tested the thing only in a slight degree. The way to do it is to take two or three spinning frames, more or less, and put wooden rolls on them, and see whether there is

any disadvantage in that. If we can get the two extreme points, we shall find a medium somewhere; but I think we are going to the extreme in weighting the middle roll, adding complication to the frame, and expense in covering the roll.

Mr. BROWN. I have been very much interested in the talk here to-day about long draughts; but one thing has struck me as very odd, that is, that in every case where they have tried to make warp with double roving they have not made any very material gain, while in filling they have gained very decidedly. Now, what is the reason for that? I am sure I do not know; but, in theorizing upon the matter here to-day, we find very generally that filling roving is made from the same slubber and intermediate as the warp: consequently there must be a larger draught on the filling fly-frames; and when the filling is kept distinct in the carding room the usual method is to incorporate waste with it, either of which would make poor roving as compared with warp. Now it seems to me that it is proved here to-day that you can use poor roving by doubling it on the spinning frames, and, if your roving is good, it will spin as well single as double.

Therefore, gentlemen, if your carding machinery is not equal to making good work, the best thing is to get rid of it, and put in some that will. [Applause.]

Mr. DRAPER. I would like to have the gentleman quote the testimony there has been that they are using poor roving In any case, I have not heard that they are using poor roving, because they found it run better double. There has been no testimony given here to-day to that effect, at least, not in my hearing.

Mr. BARKER. In answer to that, I think the gentleman who sits over there [indicating Mr. Lippitt], in making his argument for long draught, used this phrase, if I am not mistaken, that where thin places come in the roving, by putting two rovings together, you overcome that thin place; that is to say, a thick place is bound every time to come where the thin place is on the other one. [Laughter.]

Mr. LIPPITT. The gentleman will excuse me: I did not say it will come every time.

Mr. BARKER. Well, I put that in. [Laughter.] Now, it seems to me that this matter is one of vital importance; and I presume that seven-eighths of all the manufacturers here present have thought this over, and tried it in some form or

other since we met here the last time; and it is very interesting to me to bring out this discussion, and let us see what there is in this fourteen and eighteen and twenty inch draught. If there is any thing in it, we all want it; at least, I do, for one. Now, it seems to me, in the first place, that we have started on the wrong basis. Every one that has spoken on this subject in favor of long draught had finally switched in somewhere poor roving. Now, I am going to start on the basis of good roving; for that is the foundation of all manufacturing. Without good roving, well made, the whole thing is a partial botch from the time it leaves your picker until it gets into cloth. That is my experience in the matter. Hence I should start with good roving. Now, I contend, with good roving properly made, with proper draught, and proper doubling with three operations at least of roving frames, that you can make just as strong yarn with single roving and seven draught. If I had my paper here, I think it would show that the single roving with seven draught was stronger than the same roving doubled with fourteen draught. I have tended the frames myself, and I know some thing about it. And certainly I should rather tend a spinning frame with half the number of bobbins to take care of than I would double the number. I do not believe there is a girl in Christendom that can tend so many spinning frames with double roving, *if they have double draught*, as she can on single roving if the roving is right. But if it is bad roving, and you are going to fix up the bad roving in the spinning frame, it is all right. I would rather have four doublings, if it is bad. [Laughter.] Hence it strikes me it is a very important question; and I think that we should start with good roving, and see how that comes out.

Mr. Stiles. I would like to inquire of the gentleman who has just sat down, if, in his experience in running spinning frames, he ever made any yarn or roving that was absolutely perfect, that he could not in the length of a bobbin find a fine or coarse place in the yarn.

Mr. Barker. Nothing on this earth is perfect, and I do not expect to see perfection until we all get up yonder [pointing upward], and I expect to meet you all up there. [Laughter.]

Mr. Stiles. Then it seems to me that the gentleman has assumed an utter impossibility. [Renewed laughter and applause.]

Mr. DRAPER. I have been about cotton-mills for fifty years; and for all that time, and under all circumstances, I have heard people talking about doubling and putting two strands together there, and roving here, and saying it would have the effect to even the yarn. Now, we have got a man that is talking about making perfect roving. If he succeeds in making that, I think he will succeed in maintaining his argument. But I was talking of roving as you find it, and as people are capable of making it, and as they are making it, and as they find it profitable to make it. You will find it profitable to use double roving for making filling. I have no doubt but what you can spin more yarn of as good quality on warp, because, when you reduce the twist as little as required, your front roll is speeded up, and that means a greater quantity of yarn from the frame. Now, then, girls tending a frame put double roving on, and the roving does not run off any quicker from the bobbin. It is a question whether they will put a roving bobbin in one place or another. They have more put in when they start the frame. It seems to me the gentleman has not examined the subject so fully, neither has he tried so many experiments, as some of the rest.

Mr. BARKER. I did not mean to say (if I did say it, I will take it back) that we can get perfect roving, but that is the object to be sought for. I do not suppose perfection exists in a cotton-mill to-day. In the matter Mr. Draper has brought up in regard to a double number of bobbins, they are more crowded. There is not room for them. You cannot do the work so handily as you can with single roving, and hence it is more work. In regard to the twist, some of you have no doubt seen two rovings, black and white, drawn together. I want to know if anybody ever saw two rovings, black and white, drawn together, as we do, many of us, in making colored work, when the twist is even. That, it seems to me, illustrates the matter pretty well. In looking at colored yarn, where there are black and white drawn together, you will always see more or less unevenness, one thread drawing more than the other, and it does not draw even. Now, the question has arisen in my mind, it is quite possible that white roving does the same thing. If it does, I do not see how it is going to make it stronger.

Mr. KILBURN. I think, if we should turn back to some early

reports of this Association, we shall find that this subject had been well ventilated by a former member, Mr. Wheelock of Norton, I think, during the first seven years. They laid very great stress upon the value of two rovings being drawn on the same rolls, and then twisted together. In fact, I remember quite distinctly that he talked so long and so earnestly about it that many members of the Association were disgusted with the subject. But I have since been made to believe that we made a great mistake in not doing what he said. I think there is no question as to the value of two rovings being twisted together, and the fact that you can get twenty-five per cent stronger yarn from double roving than you can from single.

QUESTION. Using double draught?

Mr. KILBURN. No, I know nothing of double draught. I am only speaking of the advantages of twisting the two slivers together, increasing the strength. I think we shall find it profitable reading to peruse some of the former reports of this Association, and see what Mr. Wheelock had to say on this subject.

Mr. GARSED. Mr. President, I have had, as you are aware, a good deal of experience in cotton-spinning, dating back to 1827; and in that time we have made a great deal of double roving, but not double draught. For many years we have made a specialty of such yarn, getting a higher price for that special yarn; but in no instance have we exceeded, probably, eight or nine of a draught to make an extra yarn from double roving. Whenever I have tried, and it has only been recently, to make double-roving yarn with excessive draught, it has always been at the expense of a want of uniformity in the size of the thread. Sometimes, in testing the breaking-strength of the yarn, it would appear to bear a greater weight, notwithstanding the fact that it was uneven to the eye. Only a few days ago we were making on our mules some yarn — I think, No. 9 — for a special purpose, and it was from double roving. There were two mules running in that way. One was running on double roving with a draught of nine, the other with a draught of thirteen. Now, the yarn, to my judgment, was not worth as much within twenty-five per cent where we had the excessive draught — I am speaking of appearances now — on the one that had nine as against thirteen. But I do not rely upon my own experience only. We must look at the practice of the early spinners, and the spinners down to to-day. Why is it

that the thread-makers put in doubles from twenty to forty thousand? They double from the lapper; they double upon the cards; they double from their combers; and double, and double, and redouble, until before they get it into yarn it will number up sometimes forty thousand. Now, we know the importance of perfectly uniform yarn in making sewing-thread. If there is a necessity in that case, why is there not a necessity in the ordinary work that we are doing, with this difference, that we do not apply the same crucial test to the weaving of yarn that you are obliged to apply for sewing thread?

Mr. DRAPER. I would like to know if they do not in all cases double at the spindle?

Mr. GARSED. I think they do always. But the matter before us, gentlemen, to-day is not a matter of doubling at the spindle, because there is no question about the superiority of the yarn made from double roving. But do not let go of the subject before us. Is it as good work with fourteen of a draught double roving, as it is with seven of a draught single roving? That is the question before you. I do not believe it a bit. [Laughter.] We have never tried the experiment of giving our customers fourteen of a draught, and calling it double-roving yarn, because I do not believe they would accept it. But I propose to try it when I go home; for some gentlemen here have spoken so warmly on the subject that there can be no doubt that they are in earnest about it. I cannot understand how we can put fourteen of a draught into the spinning frame, and have better yarn. Yet gentlemen say it is so in their experience; and I will know more about it before the next meeting of the Association, whether it is a fact or not. I tried some experiments a few days ago; and, in confirmation of what was said here, the yarn is coarser. A draught from fourteen makes heavier yarn than from seven; consequently the yarn is heavier, as twenty-five is to twenty-six: therefore you gain that much. Is the yarn from the same cotton, the same carding, the same preparation, the same slubber, intermediate and roving frame, and same size roving, — is that equal? I am not saying, any better, for I do not believe that. [Laughter.] But is it equal, both having the same draught? Now, I could cite instances, as my friend Barker has said, of double-roving yarn, having one white, one black, or brown, or red, or green, or any other color; but I have never yet seen a yarn made even in that way. It

would be supposed that each roving, if you have two, would make a very fine yarn. I have no doubt of that. But it does not make even yarn in black, or white, or red, or orange; for I have tried it five hundred times, and for twenty-five years, and never yet saw an even draught from two rovings, one white and one any other color. Hence I infer there is no such thing as perfect evenness in your yarn as it comes to the front roller of a spinning frame. But I have seen a great deal better yarn, where the work was all done properly, and the roving was proper size for yarn to be made. I have seen a great deal better from double roving than I have ever seen from single, and we always got a better price for doing it, because it cost more money to do it. You cannot get such a draught on any spinning frame, unless it is specially made, so far as I know. At least, I have never succeeded in doing it. Is it worth our while to accept any part of it unless we know it to be a fact? Then, I say, take your kids off, and go ahead. Now, I will answer my friend Birkenhead about the wooden roller. The use of a wooden roller between the front and back rollers seems to be more to even the fibres in parallelism — that is to keep the fibres from curling up — than for any other purpose I can imagine. In proof of this, in a French mill, some years ago, I noticed for the first time in my life wooden rollers between the back and front roller, where the middle roller now is. I asked the superintendent what the object was. He said, "Take it out." I took it out, and in a moment the yarn was twitted: it was evidently bad yarn. "Now," he says, "put it in again." And every time I put the roller in, the twits were taken out. So all you have to do is to keep the roving down by ever so light a weight, and it prevents the fibres from rising or getting into another position, owing to the curly nature of the cotton. That is why we do not need any weight on the middle roller.

Mr. Kilburn. My attention has been called to the difference in the nature of these two cottons, where a colored and white cotton have been put together, and its nature is therefore changed. It does not draw the same as when it has the natural vegetable oil in it. I think that will account in part for the difference in white cotton and colored. I think the one is not as even apparently when made in that way as it would be when made in two slivers of cotton in the natural state.

Mr. DAVIS. Mr. President, I move you, that in order to meet the expenses of the coming year the Board of Government be, and they hereby are, authorized to lay such assessment upon the members of the Association as, in their opinion, is required, not exceeding in amount ten dollars, as limited by the by-laws.

The motion was seconded and adopted.

At this point a recess was taken until two o'clock.

AFTERNOON SESSION.

The PRESIDENT. Is there any thing further to be said upon the topic we were discussing this morning, "Double roving and high draught *versus* single roving and medium or low draught"?

Mr. GARSED. I think, Mr. President, we had better finally exhaust that subject.

Mr. DRAPER. Mr. Chairman, I was, I must say, considerably edified by putting the remarks together that were made this forenoon; and I think that Mr. Garsed, as we can call names here, is approaching the pith of this question. He told you the advantage of doubling in the various stages, and I presume he would tell you that the last stage was the most important of all. At any rate, he said that nobody thought of making a fine number of yarn unless they doubled it at the spinning the last point. So much we have found out; so much is admitted as it regards the benefit to be derived from doubling. Now, the question that we have presented here is this,—they all admit, all tell you, that an increase of draught in single roving above a certain point is injurious, exceedingly injurious. I think we all believe that it would be injurious to undertake to draw twelve, fifteen, or sixteen on what we call good work. Now the question comes in, if the increase of draught is injurious on single roving above a certain point, as I admit it is; and I do not say that it is not injurious on double roving, but we have got two things put together. The question that we are trying to find out is, Is the advantage that is to be gained by doubling the roving more than offset by the disadvantage of increasing the draught? We do not propose to say that, when you are making these very fine delicate things, where you can afford to spend any amount of money to make your roving or to make your yarn, providing you can get it perfect. That is not the problem, as I understand it, because that is the course pursued. The real question is here,—take it as practical men that have got yarn to make and cloth to make. To illustrate, we will say on print cloth, for in that region is the largest amount of manufacturing we do in this country. Now, the question is here,—we will say you are making it out of four-hank roving. You could not make it out of any finer roving than that, unless it cost you more money. You have got to have more roving machines and other

appliances, and it will cost you more money. You have got your four-hank roving. How can you get it into cloth to best advantage? Can you get it into cloth by spinning it single with a draught of seven? or can you take the advantage of doubling your roving, or the disadvantage, if there is any, of a draught of fourteen? And can you on the whole make your cloth cheaper that way than the other to better advantage? That is the problem that we are undertaking to study here. Now, from that you may branch off on to other subjects; but I expect the result will be this, that people will make up their minds that they better use double roving, and that they will accordingly see how much draught that double roving will bear. For instance, in the room of coming up to fourteen they might stop at ten; but it is a fact that, whenever you do double your roving, you put an increased draught to it any way. That is to say, it is easy to draw double roving ten or twelve, as I understand it. It is easy to draw single roving seven, eight, or nine under certain circumstances. Now, the discovery that some manufacturers think they have made is, that they can increase that draught, for the sake of this doubling up, to fourteen or sixteen, without doing as much injury by the increase of draught as they gain by the increase of doubling. I think that is a fair statement of the case, and I think people will approach it in that way.

Mr. GARSED. Mr. President, Mr. Draper says that it has been the practice wherever we use double roving we use an increase of draught. That has not been our experience.

Mr. DRAPER. Then it is not as universal as I supposed. I know instances where it is done. That is all I can say about that.

Mr. GARSED. I will say at once here, without any fear, — because I think this a subject that should be handled without gloves, whether I have made mistakes or not, — the fact is we never have attempted in making good yarn to increase the draught on double roving any more than we do on single roving. The school I went to was the thread-men of England. They uniformly charge more for the yarn made from double roving than from single roving, and this is because it costs more money. Just as my friend Draper says, the roving must be made doubly as fine, and then the draught is exactly equal. In other words, if we have five of a draught on the single roving, we have put five of a draught on each roving as it comes through the rollers: there-

fore the draught is the same as when we use double roving; but in double roving the draught is doubly as fine. Instead of using one and one-half hank, we use three; instead of four, use eight; instead of eight, use sixteen; instead of ten, use twenty. I hope this subject will be ventilated, and I hope the gentlemen present will not go out of this room to their works without determining to make experiments, and read their report at the next meeting. The subject is very important. If we are going to make cheaper goods, it must come from our machinery. While the great West has millions of acres ready to be taken up, the settlement of the question will never come from labor. I look at the labor question as one to be settled by the acres of the great West: therefore machinery, its adaptation and economy for our business, is to give the result desired. No man will work for one dollar a day, and impoverish his family, when he can go out West and take up one hundred acres of land, and pay the government six per cent on it: but the spindle or roller must be our relief at this end; and I hope gentlemen will go home, and investigate this subject to the bottom. There is no question in my mind that good yarn is made from double roving with single draught. I have no doubt of that; but I am somewhat sceptical about good yarn being made from double roving with double draught.

Mr. Garsed. One word I omitted to state before as to the speed of the front roller. We will now suppose you are giving a double draught for the double roving. We will suppose the goods is 2½-hank roving, and you are spinning No. 20, which gives a draught of eight. Now, we are going to give a draught of sixteen. My theory, drawn from seeing women spinning with the hand attached to the fibre, which is reversed in their fingers, is, that the slower she moves her fingers, the quieter she draws it from the spindle, the better is the yarn. In proof of that, we will go back to the days of single spinning, when rollers were run about sixty; and we made better yarn then than we do with a hundred and twenty, or I am a much mistaken man. But the times have changed, and we have been obliged to drive our rollers faster; but in no case has the yarn improved by doing so. You are moving your rollers in the one case with twice the speed on double roving as in single roving; and if the attenuation of the cotton fibre by the woman's finger, with her skill in spinning it on the old-fashioned hand-wheel, as she

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went along, is right, then double draught and double roving are as wrong as they can be.

The PRESIDENT. Before we drop this question, I would like to say one word, having had some experience in spinning from two rovings, black and white cotton; and not only from black and white, but from various colors, so that in either case the conditions of the cotton itself would be the same. I have tried the experiment, not with reference to obtaining strong yarn, but an even-looking twist, and to do this have taken a two-hank mottled roving, or roving which has been doubled, black and white on the intermediate, and drawn seven to make a fourteen yarn, and have also taken two rovings, one black and one white, two-hank each, and increased my draught sufficiently to make the same number; and in every instance the yarn made from double roving showed the plainer, clearer twist. The yarn made from what we call the "mottled" roving, or roving doubled on the intermediate, was a mixed roving, showing finer places, and the twist more or less run. This was done with no special reference to ascertaining the strength of the yarn, or any thing of that kind, or its qualities, or for any other purpose than to show a good even twist.

Is it your pleasure to close this subject, and take up the second subject on the list, which is "Mule-Spinning for Filling"?

Mr. WEST. I think, before disposing of this subject, that there should be a committee, although I do not wish to be one of them, to investigate this subject still further. I do not think it has been satisfactorily explained altogether yet. I think there is considerable more to be learned in experimenting; and, if a suitable committee could be appointed, I think it would be a great benefit to this Association, and have it brought up at our next meeting.

The PRESIDENT. I would suggest, that, after what has been said, the Association will be likely to resolve itself into a committee of the whole, and each member experiment on his own account.

Mr. PARKER. Mr. President, instead of appointing a committee, perhaps it would be well to continue the subject at our next meeting, and, as the Chairman suggests, the Association resolve itself into a committee on the whole to experiment during the time between now and the next meeting.

[A motion to the above effect was made and adopted.]

The PRESIDENT. Is it your pleasure to take up the second subject, "Mule-Spinning for Filling"? No objection being made, it will be entered upon at once.

[Mr. Sherman, who was expected to open the discussion, not being present, Mr. Barker was called upon.]

Mr. BARKER. Mr. Sherman, I think, will be in before the meeting closes; and I should prefer that some other gentleman should open the subject than myself.

The PRESIDENT. We shall be glad to hear from any gentleman who knows any thing about it.

Mr. DRAPER. Mr. President, as the majority of filling that is being spun and used is made on mules, I believe, or has been up to the present time, I think that it should be in order for those who are in favor of mule-spinning to set forth the advantages of that mode of spinning. Otherwise, unless there does somebody come forward to stand up for mule-spinning, I shall think they are timid. If that is really the best way to make our filling, I think that they should set forth that side of the question to begin with.

Mr. GARSED. Mr. President, so far as frame-spinning *versus* mule-spinning is concerned, ever since 1853, — I do not know how long that is; about thirty years now, is it not? — we have spun our filling on frames. At that time our mule-spinners concluded one day to go off on a drunk, and, while they were gone, we had no mule-spinning. As you recollect, the ring-frame was not as perfect at that time as it is to-day, because machinists' tools were not as perfect to make a ring-frame. The spindles were not always vertical with the ring at all points of the traverse, hence there was a good deal of difficulty in spinning fine warp-yarn on a ring-frame at that time; but we concluded it was worth the trial to get rid of this nuisance of mule-spinners that could succeed at any time in stopping the work. We had two or three hand-mules, and after a few weeks we spun our filling on the ring-frame. At that time we were manufacturers of Osnaburgh as well as Canton flannels; and we found no difficulty in spinning on the bobbin otherwise than the size of the weight, of course, being carried across the loom at every pick, and the less quantity of yarn to be made, compared with the cop that was on that bobbin, necessitating changes more frequently than if we had used cops alone. But so far as spinning, the yarn was entirely satisfactory, and much

more so than by the hand-mule. That we have continued to do to the present time. We have spun Canton flannel filling as well as Osnaburgh filling and thirty-three filling on rovings which were sent from Fall River and from Providence. The No. 7 we spun with seven turns, the thirty-three filling was spun with sixteen and one-half turns to the inch. That yarn was sent to Fall River, and woven there; and parties there could not discover there was any difference between the yarn spun on the mule and the yarn spun on the frame. There were no peculiarities about that frame. It was an ordinary spinning frame for filling, and the ordinary spindle of that time, with a button on it. The bobbin was absolutely turned at every turn by the spindle. So I can only add my testimony, that from that hour to the present, whenever we have wanted to spin filling on the frame, we have never hesitated to do it. In mule-spinning the mule spins the yarn at one operation, and winds it on the cop; while the ring-frame makes the yarn at one operation, it is wound upon the bobbin at the same time, and hence it is often the practice to put in more twist, in order to wind it at the same time it is spun, than is necessary upon a mule. The only difference between a mule and a frame, so far as I know, is that one spins the thread first, and then winds it on the cop; and the other is that the thread is spun and wound on at the same time by the traveller.

Mr. Draper. Mr. Chairman, I would really be glad, entirely glad, to hear some gentleman who believes in spinning filling from No. 40 down to No. 30 on frames; that is, who thinks that is the best and most economical mode of making filling for ordinary goods. I really wish he would get up and tell us why it is so. But if there is no such one here having talked on this matter here before, having believed in it and practised it, I will endeavor to report progress up to the present time. But I will waive my position for any gentleman who will get up here and tell us the virtues of mules for that kind of work. Now, in regard to the question of spinning filling, people seem to regard matters here, in my judgment, too much as a question of opinion, far too much as a question of opinion, and far too much as a question of argument. What does argument amount to against a fact? What does an opinion of the most celebrated gentleman amount to when you have ascertained his opinion is not based on the truth, and is contrary to results? Now, argu-

ments and opinions to be valuable should be based on facts, and the reasoning should be correct. On this question of spinning filling on frames, it has been my business for some three or four years, having converted myself to the fact that it was far the best way to spin it, — it has been my business as far as I could to convert other people in the way of business and in other ways; and a man who thoroughly believes in a thing can always make converts, I think, better than one in doubt about it. As far as progress in the matter is concerned, I left the country a year ago to-morrow; and for about eight months I had nothing to do, nothing to say to anybody on this question of spinning filling on frames. About the time I went away, there had been such an increase in the number of frames put into operation for filling and warp that there was said to be a dearth of spinners. Now, I said that we had got something new in the matter of spinning filling on frames. We had got something new beyond what Mr. Garsed said that they had at that time. We had got the means by which we could strengthen the yarn at a time when it was subjected to the greatest draught by the traveller; and by that means we could make a smaller bobbin, and put more yarn on a bobbin than they put on a cop in the same size shuttle. And as a proof of it, let me say that in a mill at Woonsocket, R.I., where there is quite a lot of filling frames, and quite a lot of first-class modern mules running on the same work, making filling for the same looms; incidentally the agent of the mill, in speaking of the results of using it, said, "We are weaving on an average two yards a day more per loom from bobbin filling than we are from mule-filling." Now, I have always called the attention of manufacturers to the fact that weaving being the most costly operation in manufacturing, the matter of using frames to make the filling on was more important in the weaving department than in the spinning department, although I maintain that yarn can be spun at less cost per pound on the average on frames, every thing considered, than it can on mules. But in the weaving department I claim that we can weave more cloth per loom, and this means less cost for weaving; and you can save, I think, eight-tenths, and in some cases we have testimony that you can save nine-tenths, of the waste on some kinds of work. To illustrate that, I have had a hard fight on this filling business to get people along as fast as I wanted to, and supposed I

knew it was their interest to go. I have, I think, in four different places, put in at my own expense some fifty thousand dollars' worth of filling frames on this condition: "I will put some frames into your mill, so many frames. You shall keep your own account, and you shall pay me the difference between the results on the frames and on the mules, taking in the cost of weaving, the saving of waste, and all the difference that appears to you in the operation. You shall pay over to me what you find to be the gain, if any, until you have paid me the price of the machine and seven per cent per annum for the use of the money." The result of that would be, if successful, that I should give them the frames, as you readily see, subject to the per cent condition. In three of the cases they didn't go two years, and in one but a few months, before they insisted upon paying up for the frames, because they didn't want me to finally realize seven per cent on the money. There was one at Norwich Falls; another, the Hampden Mills at Holyoke; and at the Hampden Mills at Holyoke they threw out some mules that were built, as they told me, at the Lowell Machine Shop; excellent mules. They found no fault with them; but they threw them out, and sold them for a trifle. They ran along, and paid me for my frames; and I met the treasurer the other day, and he said the rest of his mules were for sale, and he wanted to find somebody to buy them. Another case was with Mr. N. D. White at Winchendon. I went and put in, I think, in the first place, four frames for him; and he hadn't run them four weeks before he went and ordered enough other frames to fill up his mill, he was so thoroughly convinced, and he hasn't been sorry since. Another case was on 37 or 38 yarn that wouldn't work in the ordinary way. I made up the amount paid me. I have not got my principal and interest yet; but I think I have pretty nearly arrived at it. That was some three or four years ago. Now, facts like those, gentlemen, are something that opinions and arguments won't offset; and that they are facts you can ascertain for yourselves, if you will take any pains to find out. You can write to these gentlemen, and find out whether the facts I have told you are real, or a made-up story. The other gentleman was Mr. Saunders of the Vale Mills. Mr. Wattles, agent of the Chicopee Mills, said a few days ago, "I have thirty-six filling frames, and I am going to spin filling for cotton flannel." I think he said on them. He said,

"I have got some twenty or thirty perfect mules, and people laugh at us; but things are going now so the laugh will be on the other side." Now, there are gentlemen here who have tested this filling matter for themselves. I have described what the operation is in pamphlets and books; and, if you want to know the details about it, you can learn them. But there is one improvement in this matter that has lately come up that I think is quite important, and that is an automatic arrangement, just as soon as the frame gets all the yarn on that you want on, just the right height on the bobbin, which winds the rail down and stops the frame. Now that is one of the difficult operations in connection with spinning. That is to say, they have got to know when the frame is full; and they have got to take it at the right point, and wind it at the right speed, and stop the frame. Now, that is an arrangement to do it; and it can be done automatically better than anybody can do it, and save any trouble there is about it. Now, I know there are gentlemen here who can tell the facts as to just what they are doing better than I can. For instance, I will call upon Mr. Greene, of the Cabot Company, of Brunswick, Me. He has had excellent success, and has been a very conservative man in manufacturing. He put in, I think, about two years ago, a lot of frames to spin filling for No. 37 or 38, as I remember it, and he informed me that he was getting along very well with them. He can tell you the particulars if he chooses. I think his statement will interest you more than any thing I can say.

Mr. GREENE. The only objection that I know of to filling frames instead of mules is on account of help. I think it is a little more trouble to get help for filling frames than it is for mules, and I would defy any gentleman to pick the goods out, to mix mules. We have about five thousand spindles on No. 37 yarn. We run the front roll about a hundred and ten. There is no person who can select the goods and tell which was spun on the frame and which was spun on the mule. I am not prepared to tell just what the difference in expense is. We make a great deal less waste on the frames, and the frames run very well indeed.

Mr. DRAPER. Will you tell us the number of spindles it takes to keep a loom supplied?

Mr. GREENE. About sixteen spindles, at a hundred and ten

turns. We spin from the same roving we spin our warp from, and the draught is nine or over.

The PRESIDENT. I see Mr. Brown has come in, a gentleman whose name has been suggested as one who would enlighten us on this topic.

Mr. BROWN. Your Board of Government were particularly unfortunate in selecting me to say any thing upon this subject, I having had so very little experience with any other machine for making filling; and I therefore must take the ground that it is the only one yet invented that will make filling of the first quality, and to attempt it with any other is only to approximate. You will, therefore, please bear in mind that whatever ideas I may express of any other used for that purpose are mainly from a theoretical stand-point. The question that immediately arises when we propose buying a machine for any purpose is, What will it cost? And certainly, when there is more than one kind in the market for the desired purpose, every thing else being equal, we purchase that which is to be had for the least money. The ratio of cost per spindle, for the most approved patterns of mules and ring spinning frames, is to-day about as one is to two in favor of mules; and, where power is a question, we certainly find a very large per cent in their favor. And, as I think there can be no doubt which is the best where first cost and power is considered, the next question which will arise is, Which will make the best thread for the purpose desired? I think we all of one accord would say mules: for the instant the sliver is delivered from the rolls it begins to take its twist, and meets with no obstruction in so doing from that place to the point of the spindle where the yarn is finished; and the result is a round thread with a regular twist (as near as may be), and the vibrations given it by the rotating of the spindle throw out the fibre in such a manner as to make not only a round but fuzzy thread, which is greatly to be desired in filling for nearly all kinds of goods, and particularly so for brown cottons. I think it is generally conceded that fine numbers cost less, medium about the same, and coarse more, when made on mules than frames. We find the most difficult help to obtain is ring-spinners, for the reason the pay is not sufficient to induce large help to learn, or, when grown large in the business, to stay in our spinning-rooms; and, as a result, we must use small, young help, and have already about

exhausted the supply. Therefore, should we change all of our mules for ring-frames, I think we should be forced to use larger help, and consequently increased pay, making the cost of production more on frames, than it now is on mules, for any except the coarsest numbers. Again, we often find it desirable to pack away filling for a long or short time; and I am of the impression, that, should we allow filling to stay on bobbins for any great length of time, we should, when we come to use it, find more or less oil-stains from the bobbins; and I need not tell any one who is making goods for bleaching how great an annoyance that is, and many other objections that might be brought up, of which I will say nothing at this time, as I really did not come prepared to say any thing upon the subject, and, in fact, had notified the Secretary to that effect.

An unreportable conversation followed the reading of the foregoing statement as to the danger of getting oil on the bobbin; and a gentleman stated that with the Rabbeth spindle there would not be a particle of oil on the bobbin; that it could not get on if it were desired.

Mr. LIPPITT. I made some figures about the cost of frame-spinning as compared with mule-spinning when I saw this subject was to be discussed, and I would like to read them. The figures which I propose to give are based upon what we were doing when they were running on No. 35 yarn. The frames ran, front roll a hundred and four revolutions, and spindles about six thousand eight hundred. They ran very nicely, and we had no trouble in spinning good filling on them. I have taken the figures for the six months ending Dec. 31, 1881. I have the labor, the cost, floor-space, power, and waste. The statement is as follows: —

COMPARATIVE COST OF YARN SPUN ON 2,122 MULE AND FRAME SPINDLES FOR SIX MONTHS, ENDING DEC. 31, 1881.

FRAME SPINDLES.

Labor	$753.92
First cost, 2,112 spindles @ $4.00 = $8,448 @ 10%.	844.80
Floor-space, 1,708 sq. ft. @ 90¢ = $1,537.20 @ 10%	153.72
Power, 2,112 spindles @ 140 to H. P. = 25,080 H. P. @ 1¢	250.80
Waste (cop) per week on 110 — 44″ looms = 3 lbs. = 78 lbs. @ 12¢ .	9.36
	$2,012.60

61,828 lbs., No. 35.71, cost, 3.26¢ per lb.

MULE SPINDLES.

Labor	$685.13
First cost, 2,112 spindles @ $1.85 = $3,907.20 @ 10%	390.72
Floor-space, 2,703 sq. ft. @ 90¢ = $2,432.70	243.27
Power, 2,112 spindles @ 270 to H. P. = 17,075 H. P. @ 1¢	130.75
Cop waste, 30 lbs. per week = 780 lbs, @ 12¢	93.60
	$1,543.37

41,709 lbs., No. 35.71, cost 3.70¢ per lb.

MR. MCARTHUR. I think the securing of help depends greatly upon the locality of the mills. If you are spinning all your filling in frames, and you are in a city or large town, you can get help for that purpose more readily than if your mills were situated in a small village or any out-of-the-way place. Now this I know, that we labor under difficulty to get help to run our warp-frames; and I know that we pay as much per spindle, and a little more, than in some of the mills at Woonsocket where Mr. Lippitt is located, and he can get help enough to run warp and filling. I understand that it is a general complaint among manufacturers that in isolated places it is harder to get this class of help, but in large towns there is a better supply.

Mr. DRAPER. Gentlemen, my advice to you is, when it gets so that you must spin your warp or filling on mules, you better spin your warp on mules, and spin your filling on frames.

Mr. BROWN. Perhaps it has been some years since Mr. Draper ran mules.

Mr. DRAPER. Not so long since that I have forgotten how.

Mr. GARSED. I have had some experience in this matter; and some years ago the Bridesburg Manufacturing Company sent to various mills in Fall River frames to spin filling; and, whenever we went to see how successfully the machinery was running, we found warp being made on spinning frames. They said it made so much better warp than what they got off the mules, they adopted the plan of making their warp on it. For selvage threads no fault was found as a filling spinner.

Mr. DRAPER. Mr. Garsed does not keep posted fully. In Fall River they make print cloth: but they make their warp on mules as well as frames; and the last three concerns that have made cloth on a large scale have had no mules. The tide is setting in that direction, and nothing will stop it.

Mr. GARSED. On leaving home I put a couple of bobbins

in my pocket. It has been said here, that there is a material difference in the twist between the point of the bobbin and the larger part when the bobbin is filled. Now, there is the bobbin; and, if any gentleman can find the difference between one place and the other, why, he has got better eyes than I have.

Mr. McArthur. The point is you get less twist on the small part of the bobbin. As the bobbin increases in size the traveller revolves faster. It is hardly noticeable; but, if this could be reversed, it would be a great advantage to spinners.

Mr. Garsed. Is it of sufficient importance to require any machinery to counteract it? That is just the point I want to make.

Mr. McArthur. I say if this less twist when the bobbin is small could be reversed, it certainly would be an advantage. When the bobbins are small the yarn draws harder, and more threads break down.

Mr. Garsed. That subject was very thoroughly ventilated some years ago in this room; and I called attention at that time to the fact of the Dodge spinning frame, made many years ago, and very thoroughly made. There they attempted to spin filling upon the bare spindle, and tried to get over the difficulty of the drag of the spindle turning the traveller, to have this driver have sufficient diameter of bobbin or spindle to turn the traveller. The result of that machine was a failure because of the twits in the yarn: they had put too much twist in it. Now, we have a barrel of the bobbin there; and the only difference between that and the other is that slight difference in the diameter amounting to three-sixteenths of an inch. But we are now discussing the subject of making filling on ring-frames as against the mule, and it ought to be taken in connection with the subject discussed this morning.

Mr. Draper. I presume Mr. Garsed wants me to say something; and, if I were convinced that there were no others that were anxious to speak, I would endeavor to reply. Now, he asks the question here whether what there is to be gained would pay for adopting complicated machinery. I cannot say whether it would pay for adopting the complicated machinery in a mule-head or not; but I can say it can be done with a very simple machine, and very little addition to the frame. We not only want to overcome in this matter the difference in twist on the barrel of the bobbin outside, but we want to overcome the

difference in the pull of the traveller. Now, there is no man who knows any thing about ring-spinning that does know there is a very material difference in the pull of the yarn, whether you are winding it on the bobbin or outside; and, if you have got a traveller on that is heavy enough to wind it as tight as it will bear on the outside, it will break it down on the barrel of the bobbin. On the other hand, if you have got a traveller that is light enough to even the yarn on the barrel of the bobbin, you will have a very loose, soft bobbin, because it won't draw hard enough. Now, we want these conditions; we want the thread even; we want it slack twisted; we want it wound hard on the bobbin; we want all the yarn on the bobbin that can be got on. I think we should have no material difficulty in spinning yarn right on to the ordinary size spindle. I have not the slightest doubt but what we could do it successfully on that spindle, the size of what we call the common taper-spindle, and I could also spin it on to a paper tube of that size, and have no trouble about it. Now, if it becomes necessary to form a cop on a spindle, I do not think there is any trouble about it on the ring-frame, if it is really desirable; but for weaving puposes I do not think it is. The best cop that has been made hitherto has been the bobbin which has been wound with a quill, and they used it at the Merrimack and other mills. Now, gentlemen, I will tell you an absolute fact. I have spent more than thirty thousand dollars — I, and those connected with me — to try to get people to adopt this filling spinning as being the best way (the use of the evener I refer to more particularly), and we have never charged the first cent for its use. That shows you that you cannot give away, to begin with, a thing that people will find invaluable afterwards. I have been through with a large amount of experience in educating manufacturers to use different things. For instance, take the evener on the railway-head, which is in universal use. Now, nobody thinks of getting a railway-head without an evener any more than they would think of getting a coach without a wheel. Everybody uses it; but how many times I have been told that that was an *un*evener, that there was no use for it, that they could make better roving without it than with it! But facts will tell. When I went to work, and showed men that they were seventy-five per cent further from a given standard without the evener than with it, they began by and by to see that weighing and measur-

ing things was better than giving vague opinions abut it. All the machine-shops, I believe without exception, have fought against this evener. Well, I do not say that they are to blame for it. It costs perhaps more to build a frame, and they want to get up a frame that will suit their customers at the lowest cost to themselves. That is all well enough; but I tell you you can afford to pay three times as much as the additional cost, and have it on. You may ask, "Why do you give thirty thousand dollars to educate the people to use the evener?" I will tell you. It is not a benevolent operation altogether. [Laughter.] Because, if you use our spindles, what we do not get on the evener we do get on the spindles; and, if they put in mule-spindles, we do not get any thing. Now, that is all plain enough. I do not pretend to be wholly disinterested in all I do or say.

Mr. MERRICK. I have listened with a great deal of interest here to-day. This is my first attendance at your meeting, and I have been especially interested in the remarks of the gentleman who has just taken his seat, and also in the general theme under discussion this afternoon, as you will all of you naturally infer when my business is stated. I have nothing to do with weaving, but we all have something to do with spinning yarn, and it is always best to have both sides of a question stated; and I am always interested in hearing my friend Draper talk. I have had a little experience in using a similar device to his evener. It was not his device; but it was designed to accomplish the same result. It is necessary for us in our business to have the yarn as soft and as little twisted as may be. It is also quite necessary that it be uniform in size. We put in a thousand spindles some few years ago which had a device to change the velocity in the traveller, to compensate for the position of the wind on the bobbin, similar to Mr. Draper's. It did very good work. We were running at the same time a Rabbeth spindle with a bobbin of two heads. We were running these frames side by side from the same preparation, the same hank of roving. We compared the results in the yarns; and the result in favor of the variable velocity of the traveller, or spindle which makes the velocity, the equalizing effect upon the traveller, was not such that we ordered the second variable frame. There was one point in regard to mule yarn and frame yarn which we found out by actual experiment at this time;

which is, that absolute accuracy as to number is of no special value for weaving purposes. Then there is an element in favor of mule over frame spinning; and that is, that from the nature of the case no set of travellers upon a series of spindles on the same frame can be so accurate as to be exactly alike. Now, we made a test of that sort from the same roving, — made it on the same machine at the same time. I think it was on some new frames we had just started from the Lanphear Machine Company's shops, and we took off seven bobbins promiscuously from one side of that frame, and reeled a lea from each one of them alone, about No. 80, I think. There was a variation in the size of those seven hanks of yarn of from five to seven per cent. "Well," I said to the superintendent, " those frames are new. The travellers, some of them, or the rings, may be imperfect." He then tried the same experiment from the same roving on frames that had run three or four years, and he found quite as much variation in the yarn from seven bobbins as he did in the new frames. He then took seven cops from the mule-spindle from the same roving, made at the same time, and reeled off from each one separately a lea of yarn, and sized it; and there was not a variation in the seven of half of one per cent. So I speak of these facts as the result of our trials, which may be of interest to you, gentlemen.

Mr. GARSED. There is another element, sir, about machinery in our country that does not bear probably the same in any other, where the difference of wages is so great as it is between our country and the European spinners. Wherever we put in complex machinery we must necessarily employ a higher order of help. We must pay greater wages to superintendents, and either hire older persons to tend our machines, or employ a higher order of help by education or otherwise. Therefore the simpler machine that would accomplish the end is the machine for an American manufacturer. If we could reduce the machinery of the ring-frame down one-half from its present complexity by any invention, it would be a very desirable thing. I look upon the matter as very undesirable for one to spend money on machinery, and accomplish so little in the end. The success of the American spinner is coming from the simplest machinery he can get, and the cheapest labor we can get on them.

Mr. DRAPER. It seems to me to be necessary to make

one single remark. I do not know certainly what my friend Merrick has tried in the shape of a spinning frame; but I have never known that he had any of our devices, what we call the evener, or any thing to do with any such thing. He may have had something I don't know of; but I am afraid he is not fully posted as to what the evener is.

Mr. MERRICK. Mr. Chairman, I would state the style of machine which we run is a frame built by the Lanphear Machine Company, Phœnix, R.I. It had an accelerated or variable velocity to the spindle, which was designed to equalize the drag of the traveller, running one point faster considerably with a cone-shaped fill on the bobbin, as I said, designed to accomplish the same result in another way, which Mr. Draper did with his variable speed of the front roller, and changing the size of the sliver.

Mr. DRAPER. I have heard of that frame; and, in fact, I know about it, and run our spindle enough to satisfy me it was an entirely different thing, whatever that might have been. So that it seems to me the two will not bear comparison really.

The PRESIDENT. Gentlemen, if nothing further is to be said upon this subject, it will be in order to proceed with the next subject, — electric lighting in mills. Mr. Woodbury will present the matter.

Mr. C. J. H. WOODBURY. Mr. President, upon my return from an extended trip day before yesterday, I first received an intimation of this topic, and what was expected of me: therefore I am not in any condition to speak at as great length, even if it was desired, as at the last meeting. At the last meeting of this Association considerable attention was given to the subject of electric lighting in mills. During the last six months there has been no special improvement in the matter of electric lighting, either in economy or quality of lights which have been introduced to the market; and the problem is as it was stated then, — namely, that the light is universally considered to be a superior light, its cost being somewhat less than that of coal-gas, and greater than that of lighting by kerosene oil or distilled petroleum. This is based upon the results of the practical application of the lights, and not upon the cost of a known amount of light in either instance.

Those arranging the introduction of electric lights into mills take due care that the quantity of light shall be far in excess of what was previously furnished by gas or oil. When James Watt put in his steam-pumping engines to replace the horse-pumps in the mines of Cornwall, he fixed his unit of a horse-power about one quarter more than that of the work of a horse.

Some attention was given at that meeting to the question of dangers from electric lighting, and a record of some fires and accidents which we had had was presented. The position of the underwriters in the matter has been very generally acceded to, and during the last year we have not had a single accident of any kind from electric lighting on property covered by the Mutual Insurance Companies. In the principal mill mutual insurance companies there are eight hundred and fifty-six establishments; ninety-eight of these, or eleven and one-half per cent, use electric lights. In these ninety-eight establishments there are 2,636 arc and 11,604 incandescent lamps. A very few of the buildings use the electric lights altogether. Our experience has shown that a well-arranged electric-lighting plant, properly insulated, and with *continual* attention given to insulation, construction of arc-lamps, carbons properly confined, lamps closed at the bottom, and in the incandescent light proper attention given to the size of wires, and the closed safety catches. With those conditions electric lighting forms the safest method of artificial lighting, because by its use we are relieved of the hazard of a person going around a mill with any form of lamp lighting the various burners.

Perhaps too little attention was given at that meeting to the matter of daily tests of electric-lighting systems. It is of paramount importance that a system, consisting of dynamo, wires, and lamps, should be free from any electric communication with the earth; and daily measurements should be taken to that end, with the same precaution that we are obliged to exercise in any form of energy, as to gauge-cocks upon boilers, in watching the height of water in your pentstock, your trench or mill-pond, or the pressure of steam upon your boiler. The methods are simple, and not requiring an electrician.

Although the purposes of this Association restrain us to the consideration of the practical application of the electric lights as an element in the equipment of a cotton-mill, which is, under

some circumstances, an important feature in the quality of the production, yet I consider it no digression to say a word or two upon this matter of testing the system; and I have here two or three forms of apparatus which are ordinarily used for the purpose, and do not require an electrician. One of the ordinary forms which have been used by one of the electric-lighting companies, and before them by telegraph companies, is a small instrument called a compass galvanometer; one terminal of which is connected with the battery, and the other with the electric-lighting system, the battery being grounded. If the electric-lighting system leads to the ground, the needle will deflect when the circuit is closed. [Experiment shown.] A simpler form is the ordinary vibrating bell, commonly known as the "jingler;" and, when the circuit is closed, the bell will ring. The method of its use is, you take an ordinary Leclauchie battery such as is used with a telephone, one wire leading to the ground, the other to the jingler, and a wire from this bell to the lighting system. Now, the bell will not ring until that circuit is completed. If there is any connection electrically between the system and earth, it will complete the circuit, and ring the bell. [Experiment shown.]

Neither of these methods are satisfactory. The battery requires care, the galvanometer is affected by the jar of a mill, and they cannot detect as small an escape of electricity as the circumstances require; and, consequently, I have never recommended their use. The ordinary telephone-call, or generator, is for isolated plants the best method. When they are put up a wire fastened to a bright clean place on a gas, water, or steam pipe is attached to one binding post; and a wire from the other binding post is attached to some portion of the lighting system, when the dynamo-machine is still; then the crank is turned as if calling up a person to use a telephone, with this exception: if the bell rings, it is an alarm, and indicates an electrical conductor leading from the system to the earth, and it must be removed. [Experiment shown.] You recognize this instrument as the ordinary telephone-call which can be procured from any telephone-supply establishment, although they are all made by Mr. Charles Williams, jun., on Court Street, for the telephone company. This instrument is without the switches and connections exclusively for telephone use; and while just as good for electric testing, the cost is somewhat less than that of a complete telephone-call.

se I have now something rather more portable
have here the instrument which I designed for
rk. It consists of a Siemens armature and bat-
; the alternating currents from which ring a bell
milar to a telephone-call. When the circuit is
l will ring: otherwise it will keep silent. The
se is this: one of these clamps is connected with
eaching the ground, as a gas-pipe or steam-pipe
and the other up to the electric-lighting system.
y connection between the electric-lighting system
nd, it will complete the circuit, and the bell will
ise it is silent. This instrument has been recently
the principal electric-lighting companies for their
spectors and men who are engaged in the insula-
apparatus. The accuracy of this instrument in test-
is, by some measurements made here this afternoon
ical laboratory by one of the professors, seven hun-
that of this bell, and a hundred times as accurate as
galvanometer used.

member has any curiosity to obtain a more extended
n of the instrument, I will gladly send a copy of a
ich I read before the Franklin Institute at Philadel-
e eighteenth of this month.

re other methods used for making a test which involve
and elaborate apparatus, and require the aid of a pro-
electrician, such as ordinarily has no business in a mill.
ought up some of these points because I did not, upon
eflection, think that they had been suitably enforced
t meeting.

ARSED. Mr. President, to-day when a new President
ed, I thought something should have been said in the
a vote of thanks, or at least of the acknowledgment
ssociation of the services rendered by our late Presi-
Kilburn. He has devoted a great deal of time to it;
ough he is a busy man, he has always been prompt and
to us. And therefore, Mr. President, I move you that
ks of this Association be tendered our late President,
urn, for his impartial and gentlemanly deportment dur-
ears he has been President of the Association.

otion was seconded, and unanimously adopted.

ned.

[No. 35.]

N.E. COTTON MANUFACTURERS' ASSOCIATION.

PROCEEDINGS

OF THE

SEMI-ANNUAL MEETING,

HELD AT

BOSTON, OCTOBER 31, 1883.

BOSTON:
FRANKLIN PRESS: RAND, AVERY, & COMPANY,
117 FRANKLIN STREET.
1884.

FRANKLIN PRESS:
RAND, AVERY, AND COMPANY,
117 FRANKLIN STREET,
BOSTON.

CALL FOR MEETING.

NEW ENGLAND COTTON MANUFACTURERS' ASSOCIATION,
BOSTON, OCTOBER 1, 1883.

DEAR SIR, — The stated semi-annual meeting of the Association will be held at the Massachusetts Institute of Technology, Boylston Street, Boston, on Wednesday, October 31, 1883, at ten o'clock, A.M., with an afternoon session beginning at 2 o'clock.

The subject announced by circular from the Board of Government last June, viz. —

HOW TO IMPROVE THE RUNNING OF COTTON-MILLS DURING DOG-DAYS, will be considered : and an active discussion of the topic may be anticipated.

The subject of DOUBLE ROVING AND HIGH DRAFT vs. SINGLE ROVING AND LOW DRAFT was assigned, by vote of the last meeting, to be continued at this session ; and the members generally are invited to contribute all in their power to elucidate the question.

MR. EDWARD ATKINSON has been invited to address the Association upon the differences between American and English processes in Cotton Manufacture, as hastily observed by him during his recent short stay in Yorkshire and Lancashire.

An early and full attendance is invited.

By vote of the Board of Government,

Secretary.

The Secretary will receive nominations for membership until October 24, to be laid before the Board at its adjourned meeting, to be held at 9.45 A.M. on the morning of the meeting.

PROCEEDINGS.

PURSUANT to the foregoing notice, the stated semi-annual meeting of the New-England Cotton Manufacturers' Association was held at the Massachusetts Institute of Technology, Oct. 31, 1883, at ten o'clock A.M., the meeting being very fully attended.

The President, Mr. WILLIAM C. LOVERING, occupied the chair, and called the meeting to order.

The Secretary read the call for the meeting, after which the following gentlemen were elected to membership, upon nomination by various members and recommendation of the Board of Government: —

A. DAHLGREN, National Manufacturing Company, Nashville, Tenn.
JOHN CLARK, National Manufacturing Company, Nashville, Tenn.
CHARLES E. THOMAS, Clinton Manufacturing Company, Woonsocket, R.I.
SAMUEL C. BOWDOIN, Hampden Cotton Mills, Holyoke, Mass.
JOHN A. COLLINS, Perry Manufacturing Company, Newport, R.I.
THEODORE W. WILMARTH, Lehman, Abrahams, & Co.'s Cotton Mills, New Orleans, La.
WILLIAM P. BANCROFT, Wilmington, Del.
W. H. WHEARY, Ettrick Mills, Petersburg, Va.
WILLIAM H. MAGEE, Berkeley Mill, Ashton, R.I.
C. W. ANDERSON, Riverside Mills, Augusta, Ga.

The Secretary stated that the following gentlemen asked leave to withdraw from the Association, for the reason that they have gone out of the business of cotton manufacturing; viz., Messrs. James S. Amory, Charles E. Rogerson, Robert L. Steele, Royal O. Storrs, John Webster; and by vote their request was granted.

The PRESIDENT. The first subject calling for our attention this morning is the one announced in the circular of the Board of Government last June, which has been read by the Secretary; viz., "How to improve the running of cotton-mills during dog-days." In deciding upon this question for your

discussion, the Board of Government were satisfied that it was one in which all cotton manufacturers were equally and vitally interested, and felt that it was one the conditions of which none who spun cotton could escape. It covers questions and conditions from which none are exempt. How can we improve the running of our cotton-mills in dog-days? I do not propose to open nor to enter the debate myself, but simply to amplify the question in such a way as to call forth the fullest discussion and the freest expression of opinion. We assume at the outset, or admit, that there is a period during the summer and autumn, varying from four to eight weeks in the year, when we find ourselves somewhat perplexed to run our cotton-mills advantageously. Some have experienced this difficulty more than others. I have had one or two communications, rather paradoxical in their character, saying that the best way to run a cotton-mill during dog-days was to shut it down, and other communications saying that they knew no such thing as dog-days, there were none; showing that the opinions on the subject are very diverse. But I think we must all admit that we do suffer some perplexities, and there are some obstacles to successful manufacturing during that time. To fully appreciate this we have simply to recall the crisp, clear days in October, succeeding those of September and August; how every operative and all the machinery seem endued with new life, and the production seems to be abundantly satisfactory, whereas it had been meagre and unsatisfactory. I have, through the courtesy of some of the treasurers, been shown the cost-sheets for the months of July and August, and I have yet to see one — and I have seen a great many — that did not, during the months of July and August, show an increased cost and diminished production. Of course, diminished production means increased cost.

Now, in coming to the question, I do not, as I say, propose to debate it myself, but simply, perhaps, to guide it somewhat; and it takes a multiform shape. What is our difficulty, and what are the points of attack? Is it in the quality of the stock used? Is it in the opening, carding, spinning, or weaving-room, or in all of them? Is it in the belts and bands? Is it in the rolls? Is it in the lubricants used? Is it in the pressure of the atmosphere that exists? Has the force of electricity any thing to do with it, or can it contribute any thing

to our relief? Is it owing to the physical condition of the operatives during the period of dog-days? for we know perfectly well that this period covers the time when our operatives are more or less affected by the sultriness of the weather, and take that occasion to absent themselves from their business. And then it has become more and more a fashion among all people, extending even to the operatives, to take vacations; so we are crippled. But the fact remains that we are troubled to run our mills satisfactorily; and, where the margin is extremely close, it is a question whether some mills do not run at a loss during these months, that during the other months of the year run at a profit. But to shut the mills down would seriously cripple capital and disorganize labor. That proposition is not to be listened to for a moment.

I simply state the question in this way to put it before you, so that you may take whichever horn of the dilemma you please, and give us the advantage of your experience. Some of you, by long experience and investigation, have undoubtedly arrived at a satisfactory solution of the question; and some of you are running without knowing that dog-days are present, not knowing one day from another, while others are struggling in the dense darkness of an August dog-day. Is there any thing in locality? For natural reasons, most of our mills are located in valleys by the riverside. Is any one spinning on the hill-top, who can give us any information? Not that we can put wings to our mills and transport them to the mountain-top, but we can avail ourselves of your experience somewhat; and we therefore invite all gentlemen who are interested in this subject to speak freely and give us the advantage of their experience. The question is open for debate.

I know very well that there are several gentlemen prepared to speak upon this question, but they probably hesitate to strike the first blow. I do not know of any one upon whom we have a better right to call than upon our late President, Mr. John Kilburn.

Mr. Kilburn. Mr. President, — I received a circular calling my attention to the subject to be discussed to-day, and thoroughly understood the request that I should study the question, but I have been so occupied with outdoor work that I have not given personal attention to the subject this season. I therefore feel better prepared to follow suit than to lead in the discussion.

In years gone by, I have met with serious difficulty in dog-days, and have tried several expedients to overcome it. I have experienced more difficulty in spinning and carding than elsewhere, the state of the atmosphere being rather conducive to good results in weaving than otherwise. About the only artificial remedy that I have been able to find is to close the windows and apply steam and heat up the room. This I have done, and it worked very well until we had reached a temperature in which the operatives could not live, and then, of course, we had to desist. I always found that improved the running of the work. The result of my observations has been this: That the bad running of the work is due, partly, at least, in many cases, to the quality of stock used and to the moisture in the atmosphere. The difficulty I have experienced has been more in mule-spinning than in frame-spinning, though I have seen frame-spinning run badly enough in muggy, sticky days; and with a very moist atmosphere, and an indifferent quality of stock, I think I have seen frames running worse than any other machinery with which I have had experience. By drying the atmosphere with steam, I have been able to improve the running of the work to some extent, but not to that extent that would make it run satisfactorily. I think the same result, only in a less degree, I have obtained in frame spinning. Usually, frame spinning rooms are so hot that the test could be carried but a very little ways; the help could not endure the heat necessary to dry the atmosphere. I have always found that the quality of the stock used made material differences in the operation of spinning machinery in dog-days. With short staple cotton and a certain portion of waste which we all feel it incumbent upon us to use, and especially in bleached fabrics, I have, at some seasons, found it almost impossible, on certain days, to keep our work running; whereas my weaving would at the same time run satisfactorily, if I had plenty of help. I have had some experience near rivers; I have also had experience near the salt water; and I think I have seen near the salt water worse results than I have ever experienced anywhere. I have never been on a hill-top with a mill; I think it might improve the running of the work.

Referring to the remark of the President, that in many cases the cost of production is increased during dog-days, I would say that I have rarely passed through a season without seeing

the cost increased during the month of August and early in September, and I have attributed it in almost all cases to a lack of operatives; we could not keep our looms running, and did not, therefore, keep our production up, and hence our cost was increased. But I have found the most satisfactory results when I could obtain cotton of the best quality, the strongest fibre, and plenty of help. I have found that to overcome the difficulty to any extent that I was not able to do by any artificial means. I have settled down upon the conclusion, that the best remedy to apply is to have good cotton, a liberal supply of help, and with those two elements at my command, I believe I could keep my production up and not increase my cost.

I shall be glad to hear the result of the experience of other gentlemen whom I see here present, especially Mr. Johnston of Cohoes. I should like to hear from him on the subject.

Mr. JOHNSTON. Mr. President, — I am not prepared to discuss this subject very thoroughly, although I consider it is a very important matter for cotton manufacturers and cotton spinners. There is one thing very evident — that when we have good cotton, whether it is winter or summer, we get along a great deal better than when we have poor; but the difference between good cotton and poor cotton is very much more marked in dog-days than at other seasons of the year. I think, however, the trouble can be almost entirely remedied by using better cotton and making better preparation; but I maintain that we cannot always obtain those conditions, and hence I maintain that next summer, if we have our ordinary summer weather, with the poor cotton that we are sure to have, we shall have to be exceedingly careful in our preparation of the material in order to do good work. If there is any gentleman present who can tell us how to take poor cotton and keep up the quality and extent of our production, I think that our meeting to-day will be worth millions; for I have found that when I have used an extra quality of cotton and have made extra preparation, as in one of our mills, the dog-days do not trouble me much; that my help do not suffer from languor a great deal, neither do they want to go berrying or hop-picking; but I find in my other mills, where I use poorer cotton and do a larger amount of work, the work does not run as well in my carding and spinning; and the result is less satisfactory; my help are very much more unsteady during dog-days, and, like the manufac-

turers themselves, they want to go to the sea-shore and up in the country, so that we are short of help, which makes worse trouble.

Now, I can see only one way, if we cannot get off the desired quantity of work, and that is to lessen the production of our cards. I think in that way we should get one benefit; and then we should be more careful in relation to our picking. It is the easiest thing in the world to set the opener, and lapper, so as to make a most beautiful article of clean, good work; but when that lap, that was so beautiful from your picking-room, comes into your spinning, you have a very tender yarn; when the lap from the same cotton, that did not look quite so well, that was not quite so well cleaned, while the yarn is not so beautiful, yet it is very much stronger and better in that respect.

Now, then, with inferior cotton, which I think is a question we shall have to meet next summer, — I think before we get through the year we will know what India cotton is, and we will know what the English manufacturers had to contend with when they had to work a great portion of Indian cotton, — what plan can be adopted whereby we shall be able to get through the season, if we have the usual dog-day weather. That is a very important question. Let us take our preparations as we have them, let us take the quality of cotton as we are compelled to take it, and then take all these other circumstances into consideration, and determine what will produce the best results. I am not prepared to say what will unless we are willing to make the cost a little greater in our carding-room, and thus be satisfied with a little less production and have a little better work from it.

The PRESIDENT. I will take the liberty to call upon Mr. Ludlam.

Mr. LUDLAM. The question we have undertaken to discuss is certainly one of paramount interest to every one engaged in cotton manufacture; there can be no doubt about that; and whether we are likely to arrive at the reasons of the difficulties that embarrass us during dog-days or not, there certainly can be no harm in an expression of opinion.

I do not altogether hold to the views expressed with respect to the causes of our trouble. They have always seemed to me to have their origin more in the electrical condition of either the cotton, the atmosphere, or something else, about which we are

not at all clear, than in anything that has really to do with the moisture or dryness of the atmosphere. It is a well-known fact that we can make an artificial atmosphere. To a certain extent, Mr. Kilburn has succeeded in doing this in cases where he has closed his windows and dried the air by steam. There he has reduced the amount of moisture in the air; or rather, not reduced it, but increased the capacity of the atmosphere to take up moisture, for air always contains moisture; and heating the air does not expel the moisture, but the atmosphere, in its heated condition, is able to take up still more moisture; and it seems to me that that is one of the proofs that our trouble is not due merely to the hygrometric condition of the air itself. We all know that during the months of August and September, when these trying conditions occur with the intense heat which prevails at that season, the air is largely charged with moisture, the result of the intensely powerful effect of the sun's rays at that season. The rivers, ponds and lakes are losing water by millions of tons, by evaporation, which is, of course, diffused through the atmosphere, and the ultimate result is that we have, during the heated term, the condition of things which we speak of as "dog-day weather," and there is no question, that why those days are so oppressive to us personally, why we feel so completely relaxed and entirely averse to exertion of any kind is because of the extreme amount of moisture in the air, which prevents the atmosphere from taking up the insensible perspiration as it comes through the skin, and leaves us, for the time being, in a condition of partial "blood-poisoning." The humors that come to the surface are not taken up by the air, which is already nearly at the point of saturation; and that accounts for the extreme lassitude and disinclination to work which we are all apt to feel at that time of the year. But we can make the atmosphere, as I said before, either dry or damp, pretty much as we want it. If we shut up our spinning-room and inject steam into it, as we do into our weaving-room, we can bring it to a condition so nearly approaching saturation that it is almost one and the same thing: we can go on introducing steam until the condensation about the room is so great that it really assumes the condition of rain, and falls in drops, and when that condition is brought about, especially in the spinning-room, the work has not been found to suffer from the amount of moisture; showing that excess of moisture is not

the true cause. At other seasons of the year, we have an atmosphere, which is just at the point of saturation for days together, and we experience no difficulty; the work then goes well enough; but during these August and September days, when you cannot keep your work going, when the ends are down by thousands in the spinning-room, there is obviously, in my opinion, something else the matter, besides either heat or moisture; for we know we frequently have in other seasons of the year an atmosphere in our mills, brought by artificial means to a summer temperature, accompanied at the same time by a condition as near saturation as it is in dog-days. It is perfectly true, as Mr. Johnston says, that by improving our preparation and all our processes together, we can perhaps keep our work going better. We can no doubt do something in that way; but, after all, that is only begging the question that we were brought together to-day to discuss, which is to try and find out, if possible, *the reason* why our work runs so badly at that time; why, when we can work cotton satisfactorily in the months of May and June, and get a certain product from a certain number of spindles, we cannot do the same thing in August and September; and if any gentleman can suggest any course of investigation that will be likely to determine why that cannot be done, then I think he will indeed, as Mr. Johnston says, have turned the light upon something that will be worth millions to the manufacturing interests of the country.

Mr. KILBURN. I would like to ask Mr. Ludlam whether he considers the difficulty due to the presence or absence of electricity.

Mr. LUDLAM. On that question, I am entirely in the dark. Electricity is a thing that is so subtile in its workings and in its influences that there is no man living, so far as I am aware, who can tell you what it is. We are all groping in the dark about it. Even those who profess to know most about it, know almost nothing. It is one of the incomprehensibles of the day, but I think that a course of experiments might be instituted which would be of value. I endeavored this summer to do a little in that direction; to find some one who had skill in the use of electrical apparatus to undertake such experiments; and at last I found a young man, a graduate of the Institute of Technology, who is said to be thoroughly

posted on this subject. His name is Chase. He has made the subject of electricity a special study, and has written a pamphlet upon it which is of interest, but it does not touch the matter that we want to get at to-day? My idea was, with the assistance of this young man, to try some experiments in connection with this electrical view of the subject, which of course is only a theory; it is likely to be pricked at any moment and go to pieces as other bubbles do; but I put it forward as the best solution of the difficulty I can suggest; for as I have shown above, we can make an artificial atmosphere very like that of a dog-day so far as temperature and humidity go, without experiencing the difficulties that beset us in the August weather.

Mr. Kilburn found improvement by drying the air. But drying the air means changing the other conditions. Moist air is a good conductor of electricity, and it is a question in my mind whether, isolating his room as he did, by shutting it up partly from the outside atmosphere, and changing the condition of the air itself as an electrical conductor, was not the reason of the improvement, and not the mere drying of the air.

The electrical view of it is a much more difficult one to investigate. Whether it is the presence of too much, or the absence of electricity, or whether it is opposite sorts of electricity travelling between the earth and the clouds through the medium of the extremely moist atmosphere prevailing on these days, which is very favorable to conduction is a question I do not profess to know any thing about. But if I am at all instrumental to-day in turning investigation in that direction, and any thing comes of it, I shall feel that I am very much more than repaid.

Mr. Atkinson. I did not intend to take any part in this discussion, because I have so much to say by-and-by; but I am impelled to make one or two suggestions.

One of the advantages claimed for Oldham over all other parts of England in spinning cotton is, that the humidity of the atmosphere is substantially even throughout the year. What degree of humidity that represents I am unable to say, but I am inclined to believe, from the situation of Oldham, just on the edge of the moors, eight hundred feet above the sea-level, where the greatest condensation of moisture from the Gulf Stream takes place day by day, that the condition of humidity throughout the year is probably nearly as great as

that of our dog-days. This is claimed to be a great advantage, especially in fine spinning. If that be so, a steady condition of humidity would not be the evil which it is sought to remedy. But we have very different conditions in this country. This difficulty occurs, as I understand it from my old recollections, rather in August and September than any other part of the year: and you will bear in mind that August and September are the times when we have hot, damp days, and cool, or cold, nights. When we were trying experiments on the gelatine-roll, long years ago, we succeeded perfectly in making the gelatine-roll work well until we came to the dog-days, and then this evil occurred. The glycerine used in the manufacture of gelatine-rolls has such an affinity for moisture that, if you set a saucer half full in the open air, I believe it will add half its own weight of water in a very short time; and the gelatine incorporated in the substance of the roll attracted humidity from the atmosphere to the rolls, and in the morning they were covered with beads of moisture condensed thereon. Now I imagine (and if the practical men indulge in theory it is safe for me to do so also), — I imagine that part of this difficulty which occurs is owing to the *varying* condition of temperature, more or less, night and day. During the night every machine and every bobbin which has iron within it becomes cool, the metal being a quick non-conductor: these cold surfaces become condensers of the moisture of the atmosphere; and if you have poor cotton upon your bobbin, as Mr. Pray just observed to me, it is more liable to be affected by an excess of moisture by condensation than if it were good. Now, then, how do you remedy this difficulty by the application of heat, and for what purpose? I think Mr. Ludlam has rightly stated the purpose: a uniform, even if high, degree of heat in the atmosphere, may hold the humidity suspended and thus prevent the moisture from being deposited as readily as it otherwise would upon the cool surfaces of the machines and on the stock. It therefore occurs to me, that if you were to apply heat during the nights and save this condensation of moisture upon the cold metal surfaces during those cool nights, and then shut off the heat in the morning and start your machinery in that condition, you might perhaps approach a remedy. There is more difficulty in the mule-room than in the frame-room. Why is the frame-room hotter? There is more friction. Undoubtedly, that is

the reason. It would be interesting to know whether the stock works better in the frame-room, in spite of the dog-days, than it does in the mule-room. I suspect it does: because the stock becomes warmed by the friction, which is greater in the ring-frame than it is in the mule. I apprehend that if the mills were removed to the hill-tops, there would be more difficulty by reason of the increased amount of electricity, than from the humidity in other places. The results which I have seen in mills twelve hundred feet above the level of the sea indicate that it is harder to spin cotton in almost any dry time of the year than it is to spin cotton in the damp places during dog-days. It has occurred to me, that, in attempting to overcome the humidity in dog-days, or rather of the varying conditions of the temperature and humidity in dog-days, something might be done in preparing large volumes of air by condensation. If you can remove the moisture from the air before it comes into the room for circulation, if you can prepare the atmosphere by the condensation of the moisture in it before it enters the room hot and damp, you may be able to do something. How you can do this remains to be seen. Ice is very cheap on the banks of a canal; great volumes of air could be carried through an ice-chamber, as they are in the packing-rooms of the pork-houses. In a packing-house a thousand tons of ice are set upon posts, with a free circulation of air from the top, and the temperature of the cooling-room below is reduced to forty degrees; and so dry is the air made by this process, that the skin of the hog is apt to become too hard, and they avoid taking away too much of the moisture. The water in many of your wheel-pits coming from the hills and distant points is very much cooler than the air. The well-washed air which issues from the mouth of a tail-race is very cool, compared to the dog-day air which went in with the water, and it may *feel* damp just as the air of a cellar may *feel* damp: but *is it damp?* does it really hold as much humidity as it did when it went in? Will *cold* water take humidity from *hot* air when the two are mixed together in the flume, wheel, and tail-race? If it has parted with humidity and can be carried from the mouth of the tail-race into the spinning-room, what will be the effect? Air passing over ice is dried by condensation — is air passed through or mixed with cold water similarly affected? Whether something can be done by the application of that water, after it has gone

through the tail-race, to prepare volumes of air during this particular season so that the atmosphere should enter the room cooler, dryer, and more consistent with the conditions of spinning during hot weather, is a question worthy of consideration. I never submitted any more audacious theories than these.

Mr. KILBURN. I cannot agree with Mr. Atkinson in his theory that there will be more trouble from a dry electrical atmosphere than there would be from excessive dampness. The fact is, that we have always been able to control the state of the atmosphere, when the air is charged with electricity in a greater degree than usual (which I have found to be in the months of February and March, when we have high winds), by the introduction of moisture by steam; and in that way we could subdue and discharge the electricity and relieve us from our difficulty. I am fully of the opinion that our trouble in dog-days is due to the absence of electricity in the cotton rather than its presence; and the very fact that we can overcome the electricity by the use of steam is proof conclusive to my mind of the absence of electricity and the presence of water; which causes the thread and the yarn to sag. The effect upon humanity I am not so well prepared to discuss. I therefore should differ with Mr. Atkinson as to the effect due to the location of mills. I think that if we had our mills on the hill-tops, and there was no difficulty there except the presence of electricity, we could overcome that very easily.

Mr. LUDLAM. I have had a great deal of difficulty in running a mill through some of the dog-days that Mr. Atkinson describes, when the days were hot and the nights were cool, but about the very worst time I ever recollect was when there was not very much difference between the days and nights. Take four or five days as they will sometimes come together in the month of August, when the temperature at night is almost as high as it is in the day-time, when the thermometer will range above 90° all night, I think every gentlemen will agree with me that the days following those nights are the days when his mill runs the worst. I am quite willing to believe, as Mr. Kilburn says, that it is due to the absence of electricity as much as it is to the presence of too much; in fact, I so stated before. But I do believe that it will be found ultimately that electricity is in some way connected with the phenomena that present themselves at that time; and, as Mr. Johnston suggests,

the fact that mule-spinning is inferior to frame-spinning is due very largely to the fact that we put a little more twist in the frame-spinning than in the mule-spinning, which, to the practical mind, would be a sufficient reason for the superior running of that work.

Mr. DRAPER. It is fair for me to say that I think I should not intrude any remarks at the present time except on the ground that I was asked to consider the question and make some remarks. I have not had much time to give to the preparation of this subject, but it is one that I have had on my mind and it has been forced upon my attention most of the time for the last fifty years, and it has been on my brain to that extent that I have written different individuals when they were about getting up fine mills, asking them if there could not be some way discovered by which we could ascertain what was the most suitable state of the atmosphere for cotton manufacturing, and then see if we could not control those conditions. I recollect saying this in my communication: "We can command the state of the temperature as to heat and cold. This is important, as everybody knows. We can command it as to whether it shall be light or whether it shall be dark, because, when the sun goes down or any thing makes it dark, we can get artificial light. We can ascertain the amount of heat and cold. We can readily see how light it is; whether it is light enough for our purpose. We can also ascertain how much moisture there is in the atmosphere and control that at such times as we can keep the windows of the mill closed."

Now, one of the great things in connection with this problem is, that not only have we mills to deal with, but we have human beings in connection with them to consider, and one of the great things that we have to contend with in dog-days is the fact that humanity is in a different condition, owing to a different state of the atmosphere. Now, then, I have heard, for the last fifty years, about the atmosphere of Great Britain being remarkably well adapted to cotton-spinning, and that we could not spin fine numbers here on account of the atmosphere. I do not pretend to know, from observation, the conditions under which they operate their fine mills, but I am inclined to think there can be no question, taking what I observed of the outside atmosphere last year as an example, that there is a more evenly-tempered atmosphere on the Island of Great Britain

than we experienced here; that there is more humidity and more rainy days, or was last year, than we experience at home. Comparing last year in England and on the continent with the condition of things here, it is most remarkable. There is almost as much difference as you find out in California, where every thing is dried up at certain seasons of the year. If I am correctly informed, where they make this fine work in England, they not only have a general atmosphere, perhaps, which is better than ours, but the conditions are such that they can keep the mills, and do keep the mills, closed, and produce such an atmosphere as is desired; and the help who work, in their mills, work as they do here in iron founderies, under unfavorable conditions for health. The thing has got to be done, and therefore they find people to do it. They do not have state inspectors around, I suppose, to tell them they must not employ help in such places, and things of that sort. If the conditions are absolutely necessary, they will be consented to.

Now, it seems to me that this fine spinning is growing to be a very important business that may be done here; and I hope that all of us will endeavor to state what we know of facts clearly; and we want to begin in all cases by taking as the foundation what we do know, and have as little to theorize about as possible, and then we shall go on well, without question.

I presume it will be universally admitted that dog-day weather in this country is unfavorable to the manufacture of cotton, for some cause or other. There may be men, and undoubtedly would be if this were a political question, who would get up on the other side and declare that they did not know any difference. I do not want to meet the question in that way. If it is clear that dog-days are bad for manufacturing, let us say so and begin there. Now. I believe that one great reason why we experience so much difficulty, is the condition of the help; and I know that another reason is the condition of the atmosphere when we have to have our windows up. Perhaps it will be proper for me to state that nearly fifty years ago — more than forty-five years ago — I worked in a mill as overseer of the weaving-room on fine work. The conditions of the mill were these: we used single carding, with wooden cylinders on the cards; we made the first preparation of the roving on Taunton speeders, so called. The second preparation of

the roving was on the stretcher; we had but two operations. The yarn was all spun on hand-mules. The numbers made in that mill were from fifty to fifty-two for the filling, and forty-two to forty-three for the warp, and we made a class of goods which were woven at eighty-three picks to the inch. Some of those goods were sold for printing, and some for other purposes. In that mill, which was one of the large mills of the country at the time, we had to heat up with stoves. We did not have steam apparatus to heat the mill all over alike, and we had different parts of that mill where there would be an immense amount of condensation; and in order to get the moisture that we wanted there were great pans of water. The stove set something like an island in the open water: we also put water on the top of the stove; and this water evaporated, so that we had some steam in the room. The weaving department was my department. Now, the conditions to-day in the mills are very much improved from what they were then in respect to getting through dog-days. The conditions were not favorable to making fine yarn and making it good, and I can assure you that the difference in the atmosphere of that room at times was such that in one case you could make money, and in the other you would be obliged to lose it. That is, as we express it, "the work would go much better at one time than another." It is a factory phrase that is perfectly expressive, everybody who has been inside of a mill knows about that: "the work goes better." Under those conditions we were troubled with two extremes there. We were troubled with dog-day weather, with those sticky days, and with the difficulty of making the atmosphere alike in all parts of the room. We were exceedingly troubled with the opposite kind of weather, when things were too dry, and every thing would fly and break. Under those conditions, we used to keep the atmosphere up to about eighty-six degrees, as far as the temperature of the room was concerned, and we used to keep it as moist as we could without condensing too much in different parts of the mill.

Now what is the atmosphere that will give you the best results in weaving? The atmosphere is such that water will be running down on the inside of the windows all the time. Everybody who has been in a fine weaving-room under those conditions knows that fact, that in order to have the best conditions for weaving you must bring about that state of things.

I am one of those who believe, from what I have observed, that it is largely the subtle influence of electricity upon the atmosphere that we want to find out and manage, if possible. At any rate, if it is not any one element, it is the proper combination of elements. If, when we have an atmosphere in which every thing is going right, there is any scientist who can go to work and determine the conditions under which that atmosphere is made up, and find out what the ingredients are, the same as you would analyze any liquid or any thing else, by the operations of science, and find out what it is composed of, — if there is some way to do that, that is the thing I have been longing to find out for years. The only obstacle to doing it and being successful in this country is the fact that we must keep open windows in dog-days; our climate is such that we cannot close up our mills and exclude the outside atmosphere. That seems to be one of the greatest difficulties.

There was something brought up here some time ago that has been introduced more or less, and is spoken of in the highest terms, that I had a great deal of hope would be an advantage in this direction, and thought it might be generally adopted. Occasionally I can say a good word for something that I have no interest in; but as a rule, gentlemen, I am, like the rest of you, looking after my own interest. (Laughter.) There is nothing like being frank, and understanding one another. I refer to the Garland Atomizer. It seemed to me that that was going to be able to keep down the temperature better or heat it up by letting steam into the room and give the requisite moisture without the disadvantage of heating the room too hot. It was put into a good many different mills and it was spoken of in the highest terms in some of those mills, but it has not been generally adopted, that I am aware of. What the present condition of the thing is with those who have tested it I am unable to say.

I think I will not say any thing more on the subject at the present time, except to say this: That I have an abiding confidence in the fact that some discoveries will be made by which we can learn at least what atmosphere we are manufacturing in when we are closed up, at any rate.

Now we cannot know these things so very accurately. When we come to the concrete things that we make with our own hands, when we consider the fact that in some classes of spin-

dles a change of the size one ten-thousandth part of an inch will make a very obvious difference in their operation, how can we expect to find out with exactness the component parts of this atmosphere?

One thing further I want to say, and that is this: It is notorious that we do not have thunder-storms, which are some indication of the presence of electricity in the atmosphere, at any other time of the year so much as we do during dog-days; and the thunder-storms, it seems to me, when they come around, have a tendency to produce immediately a better state of things. I think that is the experience of all of us; that after we have had a sultry and bad time, if we have a good thunder-storm, we are temporarily relieved.

Mr. JOHNSTON. There has been some reference made to electricity. I would just like to give a little experience in relation to that matter, which may tend to show that the trouble which we have during dog-days results from the fact that we have too little electricity. So far as my experience is concerned, and also that of my father, who has been some time in the business, we were troubled more last winter, for three months, than ever before. Letting steam into the room, sprinkling water on the floor, dampening the cotton, and all other means that had ever been thought of or tried, had only a limited effect; and yet the spinning was running well, except so far as it was affected by the imperfect work made in the card-room, on account of this electricity, whereby we could not control the cotton. The spinning, with that exception, was running well, but the very deuce was to pay in the card-room. In the hope of discovering some way to remedy this evil, we got an expert electrician there, who made some progress, and he was so very anxious that everybody should know it that it was published in the newspapers that he had accomplished wonderful results, and we received a number of letters making inquiries about it. He did accomplish wonderful results by putting up wires in certain parts of the building where electricity was developed most freely and conducting it to the water-pipes. When the atmosphere was favorable in the carding-room, it produced very good results; at other times it didn't seem to do any good whatever. I thought it might be on account of the peculiar cards we used. There was no wood about them. The cylinders, doffers, and every thing else were made of iron; there wasn't a

particle of wood about them. But I was inquiring of a friend of mine about ninety miles north of us, whose mills are situated about five hundred feet higher than ours, who was using the Whiting cards, and he said he never had so much trouble. The sliver would sometimes come out of the card, and instead of going into the trough, would crawl up and jump right over on the floor. We were troubled in this way two or three months. Now, it may be that some of the trouble was due to too much electricity in the air.

Mr. Draper has referred to the making of fine yarn forty or fifty years ago. I was talking with a gentleman only a few days ago who, in 1837, had charge of a mill that was running seventy looms. They had an opener, familiarly known in those days as "the devil," having two upright shafts with knives running into each other. The cotton was fed into that and thrown out in a loose state and fed on to a single-beater Patterson lapper. Then it was doubled back on the same lapper and the laps taken from there to a single card of wooden stripping and top-flats. Those cards ran into a railway head. Then it went through three operations of drawing, and then to a list speeder, and then the roving was taken directly to the hand-mules, where it was spun into forty-two warp and made into the first delaines, I believe, ever made in America. The gentleman who mentioned it said that he never had work run more satisfactorily, and that the mill never made so much money as at the time when they made delaines; the goods were almost perfect. He said he never made any better work than he did from that single carding. Is there not something to be learned from that? How much work did they do on their picker? How many pounds per inch were they doing on their cards? How much care was used in carrying that work through the mill? Now we must do just three times as much in the picker, put two-and-a-half times as much on the card, and then we are taking out, doubling, and putting in double roving, adding to our speeders; and yet, after we get through, the yarn is no better and the work does not run any better than work made from single cards, and nothing but the single list speeder to make the roving on.

Mr. Atkinson. We have experienced a great deal of discomfort in our office from the manner of heating and bad conditions of ventilation. We have had a box constructed, open

at the top and bottom, lined with hair felt, exposing 4,200 square inches of surface on the inside. That box sets in a tub; we bring the water-pipe to it, and we spray the water through a little device which was invented by Professor Richards, by which, substantially without any drip, the water sprays itself without the use of any mechanism. It is like the ordinary fish-tail burner. The two little streams of water meet each other and break themselves up and keep the surface of that felt damp. What little drip there is goes into the tub and is drawn off. There are 18,000 cubic feet of atmosphere in the room, and the whole cubic contents of the air of that room pass though that box at the top and come out at the bottom in an hour and a quarter. We can change the humidity of the room at any time from five to ten degrees in an hour and a quarter. What is the wheel-pit of your tail-race but that box? If you can take the air from the mouth of your tail-race and force it back into the mill washed, cool and in good condition, I believe you will do some good in dog-days in your mills.

Mr. Chase is here, who has examined the subject of electricity.

Mr. LUDLAM. I mentioned Mr. Chase to the Association as a young gentleman, a graduate of the Institute of Technology, who has paid some attention to the subject of electricity in mills, the result of which were embodied in a pamphlet, a copy of which he gave me to understand by letter, a few days ago, he would be glad to present to every member. Perhaps we have not time to read such a pamphlet here, and as it relates rather to the troubles that come from electricity in cold weather than in dog-days, I think perhaps Mr. Chase would be willing to send a sufficient number of copies to the Secretary to be mailed to each member of the Association.

Mr. CHASE. I have one hundred and twenty-five copies of the pamphlet here.

Mr. LUDLAM. Then I dare say they can be distributed to the members present and they can take them home and read them at their leisure.

Mr. KILBURN. It is suggested by Mr. Ludlam that we are dealing with a mysterious agent when we speak of electricity. I fully agree with him, but the conditions which Mr. Draper has cited this morning I do not think affect that question. He suggests that in order to make his weaving run well, he wants

water running down the wall — a state of things which I have frequently seen. What effect is produced by that state of the atmosphere? It is the same effect that is produced on a clothes-line when it rains; the rope shrinks, tightens the twist and increases the strength of the rope. That is just what is done in the weaving. That trouble which Mr. Draper used to experience years ago in this way has been to a material degree overcome by the greater use of starch — by putting more sizing into the work, so that the yarn will bear the degree of moisture which is necessary to make it pliable. It has also been suggested here by Mr. Atkinson that putting a pipe leading from the wheel-pit through which the moist air could be blown from the wheel-pit into the room might relieve this difficulty. As a boy, I had considerable experience in wheel-pits, and I can remember several occasions where I have worked a good share of the night chipping segments of an old breastwheel. The water leaking through the mill-race discharged the hot air it contained in the bottom of the wheel-pit; and I think I never passed more uncomfortable nights than I have passed there. The heat was something excruciating. As the water discharged its hot air, it was almost suffocating. I have had the pleasure of doing that work with my friend Mr. Nourse here; I think he can certify to that. I think that Mr. Atkinson would be disappointed in the result of blowing air which was discharged from the wheel-pit back into the mill.

Mr. Woodbury. Mr. William B. Whiting is not here to-day, and so I will repeat one statement which he made to me a while ago. When he was agent of the Peabody Mills at Newburyport, the carding was done in the upper story of the mill; and at times the work would run so badly that it was impossible to run that part of the mill. The room was very high in the middle, and there was a large mass of air above the windows, which was not removed by merely opening the windows. Mr. Whiting procured a very large blower, whose capacity was sufficient to move the whole air of the cubical contents of the room in twenty minutes. He connected the blower down in the engine-room, taking its draft from the cool, unoccupied basement below the mill, and run a box into this upper room. When they were troubled with electricity, he would open the windows and blow this cool air into the upper room where the carding was done, and that relieved the diffi-

culty by displacing the dry air in the room, with cooler and moist air. The construction of the mill has been changed since that time; and there are mules in that attic to-day.

Mr. LUDLAM. The instance cited by Mr. Woodbury, and those cited by other gentlemen, seem to be more connected with the trouble we have in the winter time with electricity than with the difficulty we experience in dog-days. It is in the winter time that we have the greatest amount of electricity. The causes of its occurrence, and the best known means to remedy the difficulty, I think you will find in Mr. Chase's pamphlet. It is frictional electricity. It is generated in the machines; and the extremely dry condition of the air is such as that described by Mr. Atkinson as accomplished by the ice-box of the pork-packer. The air is practically denuded of moisture: it is all condensed; and there is not enough moisture left in the atmosphere to make it a good conductor; and when dry it becomes, I believe, a very poor conductor, and the electricity is retained in the machines, the belts, cotton, and the machinery of the building generally. But if anybody can give us something in regard to his *experience* in dog-days, which is the thing, I believe, we are met to discuss to-day, I should be very glad to hear it.

The PRESIDENT. I think Mr. Webber has made some experiments on this question.

Mr. WEBBER. Mr. President, I did not hear distinctly the remarks of Mr. Ludlam. I have paid a good deal of attention to this matter in the course of my dynamometer experiments in regard to power, and have found a very decided difference in the power required to drive machinery in damp weather and in dry weather. I do not know that I can say any thing as to the electrical effect on the atmosphere, or that I know any thing more about it than any other gentleman; but I have found a difference in the power required after a hot and damp night in August, when the day before had been very dry. Leaving the dynamometer standing where I stopped the test at six o'clock in the evening, and going back at nine o'clock the next morning and attaching the belt to the same machine (it having rained during the night and the morning being very sultry), I have found that the difference in the power required to drive that same spinning-frame was very nearly twenty-five per cent. I attributed a great portion of that to the friction of

the spindle-bearings from the extra strain put on the spindles by the hygrometric shrinkage of the bands. I could not conceive that the ordinary friction of the roller-bearings and the main shaft-bearings would have been affected very materially. I have noticed this same thing that gentlemen have been speaking of. In the course of the years that I have been among mills I have noticed this same inequality in the working of cotton in damp weather, which I have attributed in great part to the action of moisture, more than to any other particular cause; but I am not aware that I am in a position to give any particular information on the electrical action.

Mr. LUDLAM. I would like to impress upon the attention of the meeting the fact that moisture, as I say, is controllable, to a certain extent, in our mills. We have naturally here a dry atmosphere, much dryer than in Great Britain. We find it consequently necessary to use a great deal of steam to modify the dryness of the atmosphere, and we do that with benefit to our work at seasons when it is required. In England, as Mr. Atkinson has said, the town of Oldham is perhaps the wettest portion of that wet country. Their rain-fall is, at the lowest calculation, thirty or forty per cent greater than ours. Lancashire is the wettest part of England, and still it is the part selected, throughout the whole of England, as the part where cotton-spinning most thrives, and is most profitably carried on; notwithstanding the climatic conditions are such that the atmosphere is at the point of saturation during at least some portion of the twenty-four hours, three hundred days in the year; for I think it may be safely said that in Lancashire it rains at least three hundred days in the year. I do not mean to say all day, but it is very doubtful if they have sixty-five days entirely free from rain during the twelve months, on an average. In view of the fact that cotton-spinning can be successfully carried on in such an atmosphere as that, indeed with marked success, it certainly does seem to me that too much moisture cannot be said to be the cause of the trouble we are discussing.

Mr. DRAPER. It seems to me that what we want to find out (I am repeating, in a measure, what I have said, but there is nothing like iteration of important things) is the state of the atmosphere that is best adapted to the manufacture of cotton. We may assume that it is too much or too little electricity, too much or too little moisture, too much or too little of something

else, that interferes with our success; but what we want to get at is the exact degree of all those things, and we want to ascertain, when we get at it, how to produce that condition of the atmosphere, if possible.

Now, we have two conditions of things with cotton, — and I do not believe that machinery makes the difference in the condition of cotton. For instance, running through the same machinery, you may have a day in the year when one-twentieth part of the weight on the rolls in your drawing-room, in one condition, will be sufficient to draw your cotton what is necessary, compared with what might be required in the other extreme. For instance: there are times when you may take a drawing sliver four feet long and hold it up, and it will drop apart, perhaps two or three times. When it is in that condition it is, you may say, slippery, and holds together so little that the question of slipping those fibres and drawing them apart does not require much of any weight, nor much of any power. You take that in the extreme opposite condition and it seems almost impossible to draw a large sliver in proportion to the draft which your machine shows. There is a shrinking back, a resistance, a toughness, an unwillingness to be extended, to so express it. Now, you take these two conditions of things. You might take a piece of india-rubber and run it through rolls that would stretch four to one, and measure it after you got through, and perhaps it would not be any longer than it was before. There is something about cotton in certain days that resists draft; and one of the difficulties that we experience is, that with the machines in the same condition and with the same amount of cotton going into them, you will not receive the same product. That is to say, you put the same amount of cotton into your picker in one state of things and run it through all your machinery, and you do not produce yarn just as fine in one case as in the other; and thus changes are required to be made in consequence of the changes of condition that you will meet in the atmosphere; and it is for the lack of those changes that yarn which is made too fine, perhaps, under one condition of things, comes out differently in another condition of things. These are facts which every man of experience knows are true; that there are times when you would do well, perhaps, on your drawing to put on additional weight, unless you had already provided an extreme weight, and other times when you might

almost be required to put on less weight, or else your sliver would come out too small.

Mr. KILBURN. I want to say one word more. The subject to be considered is, what we can do to improve the running of work in cotton-mills during dog-days. The only other thing than those which I have mentioned, that I can name, is this: That it has been my custom to put more twist into my work during dog-days than any other season of the year, and I have found that to improve the running of my work materially.

Mr. GARSED. I would like to ask my friend Johnston on the one hand and my venerable friend Draper on the other, what kind of cotton they used at the time they made such a thorough success in spinning on old-fashioned machinery? Whether they used fair New Orleans, or, as we are trying to do to-day, low ordinary?

Mr. JOHNSTON. All the answer I can make to that is, I don't know much about cotton manufacturing forty-five years ago.

Mr. GARSED. Well, friend Draper can answer it.

Mr. DRAPER. As far as I am concerned, I have this to say. I think Mr. Garsed got a somewhat different idea from what I intended to promulgate. I simply stated the conditions under which we were then working. I distinctly stated that we had made great improvements in working cotton since then. I did not say that we succeeded in manufacturing as well then as we do now, if I recollect what I did say. At any rate, I did not intend to say any such thing. As far as the cotton is concerned, I think they did use a better grade of cotton for producing the same class of work, perhaps, than we do now. If the improved machinery had not enabled us to make a greater quantity of work, I should be very sorry.

Mr. GARSED. I asked the question because in my own experience, some years ago, with the identical machinery described by Mr. Johnston, — Patterson cards, Patterson pickers, a Patterson drawing-frame, and a list speeder, — we made very excellent Canton flannels. But when I look back and remember the kind of cotton we bought in those days, and think of the kind of cotton we are able to buy to-day, the whole character of the question is changed. I hope no gentleman will go away from here and imagine that we could do any thing like what we do to-day, with the kind of cotton that we use to-day, on the machinery that was used forty years ago. We could no

more do it than we can find out exactly what are the electrical conditions of the atmosphere.

Mr. JOHNSTON. I should like to hear Mr. Lockwood's views on this subject. He has had great experience.

Mr. LOCKWOOD. Since this question was brought to the notice of this Association, I have given but little thought to it. Indeed, I had to ask the question yesterday what was to be the subject before the meeting to-day, though I did recollect then that I had at some time known what it was, but it had slipped my mind.

Without going into any extended remarks, and without undertaking to theorize, though I could do that, perhaps, to some extent, I will just state, for the benefit, if it is any benefit, of the Association, the results of what thought and experience I have had in regard to this matter of working cotton in dog-days. Having exhausted every method that I could conceive of years ago, I come to this conclusion, and I have practised upon it since, and I think with some good results. It is very simple, very plain, requires no additional machinery, no additional power, no additional skill. In the purchase of cotton during the year previous to August, I endeavor to buy enough superior staple to carry me through the dog-days. Then, when the invoices are sent to the mill they are marked "dog-day cotton," and I think in that way I have accomplished more than a great many have where they have experimented in other directions. (Applause.)

Mr. GARSED. I will ask Mr. Atkinson to give us his views. Probably we can ascertain something from them to reflect upon during the lunch hour, and resume the subject after dinner.

Mr. DRAPER. If you will pardon me one moment, there is only one thing about machinery that I wish to state, and Mr. Lockwood reminds me of it. Mr. Lockwood's son-in-law, who is associated with him, has said to me repeatedly that they thought that the greatest improvement that had come up in cotton-spinning, that is, in the spinning-room, for a great many years, was what is known as the separator. As you have almost all adopted it, perhaps I may call your attention to what they say, and I may say that it makes our spinning run just as well in dog-days as any part of the year. (Laughter.) If Mr. Danielson will not confirm this statement, and say that he has repeatedly told me just that, I will give a dinner to the whole Association. (Applause and laughter.)

Mr. LOCKWOOD. All I can say in reply to that is, that when we used a spinning-frame with two-and-a-half-inch gauge, we used the separator; when we built a new mill we used a longer gauge, and dispensed with the separator.

Mr. DRAPER. It is important to have all the facts. About nineteen-twentieths of all the spinning you have for ordinary work is two-and-a-half-inch gauge; and then the question comes whether it is better to increase your gauge without the separator than to use what you have got.

Mr. KILBURN. If Mr. Draper would visit a great many mills that are spinning colored cotton, he would find there was need of a separator to separate different colors of cotton, and this is a want which his separator does not provide for. I find frequently in my mill when white cotton will work with entire satisfaction, that certain kinds of colored cotton are uncontrollable. I cannot do any thing with them. I simply stop the work, take it off the cards, put it into a damp room and age it, and when it has aged enough, then I can work it.

The PRESIDENT. Has any one else any more light to give us on this subject, or is it your pleasure to drop the question here?

Mr. BIRKENHEAD. I have one word to say on the subject. At one time, I had charge of a mill of twelve thousand spindles in England, and one of the mills used to receive orders for small quantities of yarn. We used to sell yarn, and we made various numbers. As has been stated here about the clothes-line, the band became taut, on account of the moisture of the atmosphere, presumably owing to its additional thickness, which necessarily puts more twist into this yarn, and when it becomes dry, the yarn becomes less in diameter, and consequently that twist is not sufficient to give it strength. Well, why should not this operate with the yarn as well as with the strands of the clothes-line? I was expected to get out as much yarn as any one else did, and I think I used to do it; and the way I used to do was this: I had a change of gears, both for the draft and the twist, and when I found the spinning going bad, whether it was owing to the condition of the atmosphere or not, I always put in an additional tooth, and that remedied the evil; and when I found that the spinning was going as it ought to go, and we had to keep the ends up, I would take that tooth out again. I think if the manufac-

turers of this country would have a change of twist gears, and have their machinery built so that they could conveniently take them off and put them on, they would overcome this trouble to a great extent.

The PRESIDENT. Is it your pleasure to close the debate on this question? If so, you will say aye.

The vote was in the affirmative, and the debate terminated.

Mr. WEBBER. I have been requested to bring forward some records which have a bearing upon this question. Mr. Whitman, of the Amory Mills, having found a good deal of trouble with his work, thought of the idea of putting double gears on his roving-frames; that is, putting a duplicate set of gears at the further end of the frame, corresponding exactly with those on the driving end, thereby rendering the motion of the rolls more steady; and during the latter part of the summer and the early part of the autumn he has been making a number of experiments, of which I will give you a summary of one or two results, without going through the details of the paper, the first one being where the intermediate frame was run with the old-fashioned single gearing; the intermediate and the fly frames were both changed, and another set of gears added to each end. The yarn was taken from twelve or sixteen different spinning-frames, a bundle from each frame. The average number was 24.05. The average breaking strength of the yarn was 62.98. The yarn, after using the double gears on the intermediate and middle frames, sized a little coarser, 23.89. The breaking strength of the yarn went up to 78.06 pounds, an increase of nearly thirty per cent in the breaking strength of the yarn. There was rather less variation in the size of the numbers, although not very great, but there was a very great difference in the variation of the breaking strength of the yarn from the different frames. With the old single gearing on the roving frames, the yarn varied from fifty-five pounds to seventy in the breaking strength. With the new double gearing, the variation was from 75.75 to 81.50, one-third of what it was where the frames were driven by single gearing.

He then made another series of trials between double gearing on the plan on which his old spinners were built, with the small intermediate gear set below the rolls, and double gearing on the plan on which his fly-frames were geared, with the large gear placed above the rollers. Here both frames were double-

geared. The yarn sized 23.92, and broke at 72.104. The yarn with the intermediate gears placed above the rollers sized 23.86, and broke at 75.31, a gain of five per cent in a dozen trials in different frames from a change in the position of the intermediate gears on the frame.

He then made another trial on his mule filling, where the change was made from the single to the double gearing. The yarn before making the change sized 34.99, and broke at 34.28. The yarn, after making the change, sized 35.19, and broke at 38.72.

Another set of experiments with double bottom-gearing on the intermediate, and top-gearing on the fly-frames, changing to top-gearing on both frames, showed an average size, before making the change, of 23.70, and broke at 72.62; after making the change, it sized 23.68, and broke at 76.21.

He made one trial only of a change of the gearing on the slubber. That showed a size of yarn 23.12, at the time it passed through the other processes, and broke at 72.25. After the double gearing, the sliver sized 22.80, and broke at 75.75.

Mr. Whitman thinks that some of this trouble, which is more noticeable in hot weather, is due to the imperfect action of the gearing on the roving-frames. He has been for some months devoting himself especially to this matter, and has changed a very large portion of the frames in his mill, and has requested me, in connection with this subject, to mention these facts.

A MEMBER. How long were those frames? How many spindles were there on them? Are they short or long?

Mr. WEBBER. They are long frames; one hundred and forty-four spindles.

A MEMBER. What is the gauge?

Mr. WEBBER. The usual gauge for No. 29 yarn.

The PRESIDENT. If no discussion of Mr. Webber's paper is desired, we will pass to the next topic named in the notice of the meeting; which is a report from Mr. Atkinson of his observations while in England of cotton-mills and methods of manufacture.

REPORT ON ENGLISH COTTON-MILLS AND METHODS.

BY EDWARD ATKINSON.

Mr. ATKINSON began by saying: I never before so much regretted my lack of real technical and practical instruction in cotton-spinning as in my recent visit to England. I should never have dared to bring before you what I am now to present, had I not made a partial report to the directors of the Company of which I am president, a copy of which falling into the hands of one of your executive officers, led to an urgent request, to which I have submitted. If I bore you it is their fault, not mine. It is not so ponderous as it seems (laughter), as I will skip a good deal of it.

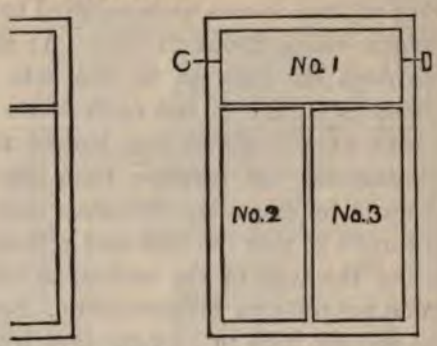
Having spent the last part of my recent stay in England, in Yorkshire and Lancashire, inspecting mills and machine-shops, I observed many differences between English and American practice, a statement of which may be of some use. I venture to express no opinions upon these differences, because it is some years since I was directly engaged in manufacturing, and also because my observations were of necessity somewhat superficial. You will take them for just what they are worth.

The first cotton-mill visited was the mill of Messrs. Bowman Brothers, at Halifax. These gentlemen own about 150,000 spindles, which are operated on medium and fine yarns, spun from Orleans, Memphis and Egyptian cotton. [A picture of their mill is submitted herewith.]

Dr. F. H. Bowman, of this firm, is the author of the well-known book upon the cotton fibre, and has lately published a most valuable text-book upon the physical sciences for the use of *intermediate* schools and colleges. His scientific attainments, coupled with the practical skill of his brother, which he also shares, may render his practice worth the attention of all spinners. With his consent I submit the following observations which were made in his new mill.

1. The mill is of fireproof construction. The main girders are of cast iron, crossing the mill from side to side between each window at a distance of 10 feet 4 inches from centre to centre. These girders are of different lengths, resting on the tops of

Light No. 1 opens inwardly on an axis at C and D.
Light No. 2 and 3 are fixed.



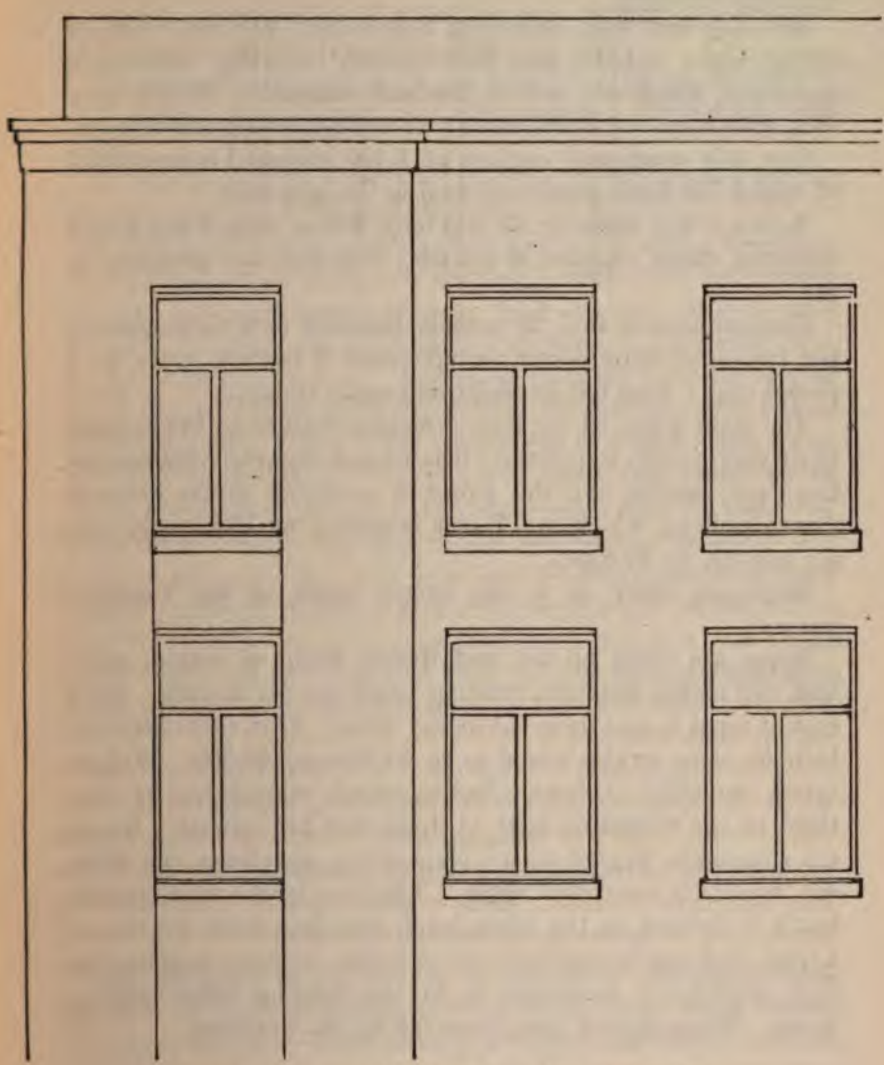
FOUR FEET WALL. SIX FEET WINDOW.

The rough plate-glass costs more than common glass, but is much less liable to be broken. The sash costs less. The ratio of difference would vary in this country, and I therefore obtained no cost statement.

The advantages claimed are that the thick glass retains the heat in winter; that the light, although a little less, is much better diffused (the glass has a dingy look outside, but within I found the light all that could be desired); that no shades are needed to keep out the glare of the sun; and that the reduced liability to breakage fully offsets the higher cost of the glass, without reference to the lesser cost of the sash.

An inquiry elsewhere developed the fact that it was somewhat unsafe to use such heavy glass in skylights sloping toward the sun, on account of breaking from expansion. If, however, great care is taken that the glass does not fit too tightly in the frame it may not break. For our climate, however, it would be much safer to set in skylights, or monitors, two thin plates of glass in one sash with an air-space between, or to use double windows. In this way only can the condensation of moisture on the inside be prevented. Thin glass may be lightly coated with paint to prevent glare. It would be well for you to visit the one-story mechanic art-shops of the Institute of Technology, where long skylights are on their trial as a substitute for monitors. The English window seems to be well suited for vertical windows in this country. How far thick plate-glass would suffice without a double window remains to be proved. I have asked Professor Ordway to make some experiments on the non-

conducting of heat and the diffusion of light, making use of several varieties of glass in such tests.



ENGLISH MILL — PROPORTION WINDOWS AND WALLS.

ROPE-DRIVING.

3. I was surprised to find in this and other first-class mills that ropes instead of leather belts have taken the place of the upright shafts and gears which were formerly used.

I can best give the reasons for this practice by submitting the following statement in regard to the "new mill" of the Messrs. Bowman Brothers.

Mill 225 feet long, including rope-house; 105 feet wide; 6 stories high; 141,750 feet floor-surface, including rope-house and stairs, which are outside the wall, containing 60,000 spindles, with room for 20,000 more; all mule-spinning and twiners.

One pair compound engines of 1,400 indicated horse-power, of which 700 horse-power are used in the new mill.

Boilers 8 feet diameter, 30 feet long, 2 flues each, 3 feet ½ inch diameter, steam pressure 80 pounds; 5 boilers are generally in use.

Consumption of fuel, 2¼ pounds Barnsley nuts (bituminous) per indicated horse-power; evaporation 9 pounds water to 1 pound coal. Fuel fed by Helix automatic stoker.

The main wheel on the second motion shaft from the engine, or driving-pulley, is grooved; it is 12 feet diameter, 104 revolutions per minute, and the power is conveyed to the grooved driven pulleys, which are 7 feet diameter, at 180 revolutions per minute, by 20 ropes.

Engineers differ as to the proper angle of the V-shaped grooves.

Ropes are made of the best Russia hemp or cotton, cable laid, two inches diameter, running 4,320 feet per minute. First cost of ropes is said to be £175, say $875. First cost of leather belts for same service is said to be £1,700, say $8,500. Weight saved, one-third at least. Power saved, represented by one-third of the weight of belts at 4,320 feet per minute. Ropes are sometimes treated with a preparation, sometimes run without, especially the cotton ropes. The wear is of course greater, but it is claimed, on the other hand, that they wear out one at a time, and can be replaced one at a time without stopping the mill, during any meal-time or in the evening after working hours. These figures were given me by Dr. Bowman.

REMARKS.

If rope-driving should be approved, it would be greatly to the advantage of the underwriter for the following reasons: —

1. Almost entire freedom from the danger of water damage.

2. Much less friction on the heavy bearings where most of our destructive friction fires have occurred.

3. Smaller orifices in floors, in mills which have no separate belt or rope-rooms.

It may be added that the present tendency in England is toward the substitution of ropes for belts throughout the mills, so far as the substitution is possible.

The rules for rope-driving have been given me, as follows: —

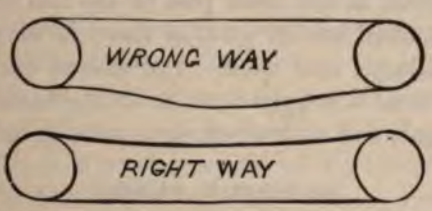
1. Never use pulleys of less diameter than six feet for main work.

2. The greater the velocity of the rope per minute the greater the efficiency, up to five thousand feet per minute.

3. For great power ropes two and one-fourth inches diameter, two inches when stretched are best; cable laid with three strands, and each strand of three finer strands. Where small power is required it is not necessary to have the rope cable laid, or so great in diameter. For ropes of small diameter smaller diameters of pulleys may be used than six feet, and cotton ropes are preferable to hemp. For large ropes or outside work hemp is better than cotton. Cotton ropes made from yarn, counts about 20° to 30°, are better than those made from rovings.

4. With a rope two and one-fourth inches diameter and pulleys above six feet, each rope will drive ten indicated horse-power every one thousand feet of rope speed per minute.

5. Whenever circumstances will allow, the slack side of the ropes ought always to be on the top so as to keep the rope tight in the groove where it stretches.



Dr. Bowman says: "There is not much difference in the friction of ropes and belts, but the belts are so much heavier that they take more power to keep in motion, and they cause much more *back lash*, because they get swinging and undulating when at high speed, and are a much greater weight on the neck of the shafts, both driver and driven."

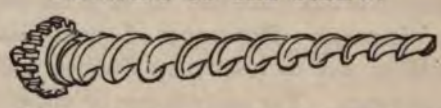
In this connection I may call your attention to the tarred cotton rope and tarred spindle-banding prepared by Mr. Thomas H. Dunham, of which I have samples before me. You will ob-

serve that while thoroughly impregnated with pine tar they are reasonably supple, perfectly free from stickiness, and are said to be very non-elastic and substantially free from the effects of humidity.

THE HELIX AUTOMATIC STOKER.

4. So far as I have information, but little success has attended the use of automatic stokers in this country, but perhaps the simplicity of this invention may warrant some attention being given to it. The inventor is Michael H. Smith, Crossley Street, Halifax, and the patent is held by him.

DRAWING OF THE SCREW.



It is not possible to give an accurate impression of this apparatus without a complete diagram, but it may perhaps suffice to say that three screws, each one like the other, but each varying in size, shape and pitch of screw according to the size of the fire-box, are worked in channels below the level of grate-bars, which grate-bars are placed between and at the sides of the screws; the coal is forced onward and upward by the same revolution, so that the fire is always bright upon the top, and the gases which are distilled in the lower part of the bed of coal are substantially consumed above, so that there is very little smoke from the bituminous coal used. The screws feed the furnace automatically from a hopper in front of the boiler. Small coal only can be used, and coal which does not run in heating.

FIREPROOF FLOORS.

5. The construction of floors of iron and concrete will be described elsewhere, but they are covered with one and one-half inch plank; no concrete having yet been found over which "as equable a temperature can be maintained," or "in which dust injurious to bearings can be avoided." Many kinds have been tried, concrete with granite face being best.

OVERHEAD PIPES.

6. The heating pipes in this mill were single pipes, two inches diameter, hung overhead down the centre of the mill;

the steam is carried into three top stories, and the lower rooms are heated by hot water, which is condensed in these pipes and sent through the lower rooms, and is afterward returned to the boiler, or used for washing.

LUBRICATION OF HEAVY BEARINGS.

7. Observing that oil only was used upon main bearings, delivered from oil-cups which are furnished with a trip-valve delivering a given quantity of oil at each revolution of the shaft, Dr. Bowman assured me that his own experience concurred with Mr. Woodbury's experiments of last winter, of which the results have not yet been published because the work is still incomplete. A preliminary report on this subject is submitted herewith.

The deductions which I refer to are these: —

All greases, or semi-solid materials which are used for lubrication, are fit for their purpose only when heated sufficiently to become fluid or oily; that is to say, they must first be converted into oil by heat, and heat is costly and dangerous; and although the cost of greases may be in the ratio of one cent per pound for grease against one dollar per gallon for oil, they are the most expensive lubricants where power is developed at any appreciable cost. The greases must also be condemned as dangerous if this theory is sustained by the experiments which will be continued by Mr. Woodbury next winter.

It is not difficult to test this question upon any main bearing. The method is as follows: —

Bore a hole about half an inch diameter in the cover of the box; in this place a copper case or cartridge resting on the shaft; in this case put water and pack a thermometer; then observe the difference between any grease and a suitable oil. The results of Mr. Woodbury's observations, as far as they were carried, were that greased bearings run at 110° to 180° F., and oiled bearings at 30° to 40° LESS. He used upon our machine Downer's heavy spindle oil, and a mixed oil made by L. B. Squier of New York, and long used by the American Print Works. The one was a little the best lubricant, the other a little more durable; either much safer than any grease, and either much cheaper if the cost of power is considered.

The Downer oil was subject to the least evaporation.

THE USE OF THE MICROSCOPE AND POLARISCOPE COMBINED.

8. Dr. Bowman assured me that by applying polarized light to the cotton fibre in a microscope, the injury to each fibre could be visibly traced, and the place designated where the deterioration is accomplished in each process; especially the injury done by heavy weights on the drawing. He also stated that the image showing depreciation could be thrown from a camera upon a sheet with a suitable polariscope, and the photographic image could also be obtained, but he could not describe the methods "without almost writing a treatise on optics." It will be remembered that Dr. Bowman's experiments, given in his book, prove that only about one-fifth to one-fourth of the normal strength of a given number of mature cotton fibres can be found in the best yarn.

My next inspection was given to a mill in process of construction in place of one burned in Bolton. It is to cost five shillings per spindle extra for solidity, strength and fire-proof quality. Mill six stories high; six feet window space, four feet wall on face between windows; walls forty-two inches in lower stories; twenty-eight inches upper story; bricks used 9 x 4 and ½ x 3 inches, or about twice as large as ours; mill, one hundred and twenty-eight feet wide, to carry mules of one thousand and fifty spindles each, one and five-eighths gauge. This is said to be the size of mule which can be operated at least cost; 82,000 spindles, 50's to 120's; one thousand two hundred and fifty horse power; twenty-eight ropes; iron girders ten feet four inches on centres.

FLOORS.

Between the girders what may be called iron joist are placed midway between the top and under side of the girder, — about fifteen inches on centres, three inches deep; boards are placed under these joist, to be removed when the concrete hardens, and then eight inches of coarse concrete is placed, enveloping the cross joist. This concrete is composed of broken bricks and cinders, mixed with about one-sixth part of Portland cement.

Over this three inches of fine cinder concrete, and one and a half inch boards. Wooden joist are set at proper spaces in the three-inch concrete to which to nail the floor and fasten the machinery. The wooden joist are bedded in concrete made of about six parts ashes to one of *lime*, and are not found to decay.

After the concrete is set the boards are removed and the ceiling is scored to hold plastering, and then skimmed and whitened.

By the kindness of John Hetherington & Sons I have obtained since my return the diagram of this mill, which is upon the blackboard. If you elect to pay the cost of a heliotype of this drawing, it is at your service. The elevation has been made by our Mr. Dabney, to show the ratio of the windows to the wall surface.

As I have stated, this mill will cost more than the average fire-proof mill. As nearly as I could ascertain, an average fire-proof mill now costs thirty-two shillings per square yard, which is about ninety cents per square foot of floor, including stair spaces and rope spaces. These latter, i.e., rope-rooms and stairways, are usually inside the main wall.

I have presented this sketch of a modern fire-proof (so called) English mill, because I think the proportion of wall to window is worth your attention, especially the way in which the top light of the window is carried to the very ceiling between the girders, thus assuring good ventilation and the maximum of light. Except for this top light, rooms one hundred and twenty-eight feet wide in the clear could not be considered.

On the other hand the roof is bad, and I am satisfied, from investigation since my return, that if the combustible contents of such a mill get well on fire, the building will be destroyed about as surely as if the floors had been made of timber and plank. I am inclined to believe that a floor constructed of heavy timber, three-inch plank, with top floor laid over mortar, and ceilings protected with plasterings on wire lath, is a safer and more fire-proof mill than one composed solely of brick, concrete and iron, unless every part of the iron is imbedded in or protected by the concrete, which is not the case in this plan. For the alleged danger from fire to the class of mills represented by this plan I have the highest English authority. I had no time while in England to ascertain the facts for myself.

MACHINERY.

Aside from the matters already treated, my attention was especially called to the carding engine of the "Leigh" pattern, perfected in its mechanism, fitted with a revolving apron of top flats, which are stripped and ground as they pass over on the outside, and also fitted with *a saw-tooth licker-in.* This latter

device was wholly new to me, but I found it was an old invention lately adopted, and now in general use for fine as well as coarse work, the shape of the teeth and the spacing of the saws on the cylinder being varied on Sea Island, Egyptian and American cotton. The saw is made like a band-saw, one-quarter inch from back to front of tooth, one-quarter inch from point to point, pitch of teeth like those in use in a splitting saw.

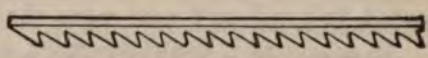


DIAGRAM OF THE SAW — FULL SIZE.

The adaptation of the shape of the tooth to the special staple of the cotton is deemed very important. I understand the saw pictured above to give the shape for medium American staple.

This saw is set as follows: The cylinder is grooved spirally, one-eighth, one-tenth, or one-twelfth inch gauge, according to the work, and this saw is wound into the grooves so that the teeth only project. When placed, these teeth are far enough away from the feed-rolls to avoid cutting the cotton, and the fibre is transferred to the main cylinder, while the leaf and notes are knocked out in a most complete and thorough manner. It has at the first glance a most destructive look, but its very general adoption by the best machinists, and the most skilful spinners, indicates that this appliance works no harm to the staple, and its cleansing effects need no other testimony than the condition of the waste under the cards. Dr. Bowman testified to its great value, even on Sea-Island cotton.

In other ways the construction of this revolving-top card has been carried to great mechanical perfection. For instance, cylinders made in the shop of Messrs. John Hetherington & Sons, fifty inches diameter and forty inches face, are first turned and afterward ground to a true surface, and the arches upon which the tops revolve, and by the surface of which they are guided, are then ground to an exact adjustment to the particular cylinder used in that particular engine, by means of a special machine lately patented by the Messrs. Hetherington.

I may here suggest that the English method of stripping cylinders with a revolving brush may be much more effective in cleaning and much less injurious to the card than our common use of hand-cards.

Card clothing made of tempered steel wire is coming into

use, and is said to be the best. Caution is needed in grinding tempered steel wire on account of sparks, on which account tinned wire is to be preferred. Tinned wire teeth set in a rubber back are also in great measure free from the danger of water damage.

Dronsfield's machine for winding on or mounting card fillets with a uniform tension is doubtless known in this country, and calls for attention.[1] The Dronsfield Brothers claim to have made improvements in the card-grinders also.

It is claimed that the force required to operate fifty of the carding engines named, fifty-inch cylinders, forty inches on face, is two men to attend to strippers and grinding, one lap-carrier, and two girls to carry cans.

Standard of first-class work on American cotton, three hundred and fifty pounds to each card in fifty-six hours and a half. These cards can, however, be driven up to six hundred pounds per week with tolerable results, and will do five hundred pounds per week of fair work.

The standard of mule-spinning is said to be twenty-seven and a half hanks warp, or twenty-nine and a half filling per week. English working hours are: ten hours, five days; six and a half hours on Saturday, cleaning-time included. This gives about fifty-four hours of actual work per week.

From another source the standard of mule-spinning was given at "four draws in fifty-two seconds," on No. 32.

For combing-machines in the Oldham exhibition the standard is given: "Eight ten-inch laps to one machine; one hundred nips per minute; three hundred pounds combed in one week." This claim is said not to be sustained in practice, but that a speed of eighty to ninety nips per minute is a fair average. The art of combing has been carried even to combing Madras cotton, one of the shortest of the India staples. In treating this class of cotton the staple is drawn toward the mechanism, which nips it by an air-duct.

Roving-frames and ring-frames have a much heavier look than ours, and I think take more power. The large proportion of engine-power provided to run mills devoted to spinning only, without weaving, points in this direction also.

[1] The Dronsfield machine is used in some of the mills of the United States, and was illustrated in "Boston Journal of Commerce," July 30, 1881.

CASE-HARDENED ROLLS.

It can hardly be doubted that case-hardened, fluted rolls, which cannot be cut with a file, and which will stand almost any blow without a dent, must be economical in the long run. They are now furnished at about eight cents per spindle extra price. Here is an example.

A machine invented and made by the Messrs. Hetherington for turning, or rather grinding, off an impaired surface of a leather-top roll, is much used.

A varnish is used to give a new and true surface, and some rolls are turned down twice, giving three surfaces in use before they are taken off.

TOP-ROLLS WEIGHTED.

I think that among all the spinning-frames exhibited at Oldham, comprising examples from nearly every maker in England, not a single one had *covered* middle or back rolls.

The rule appears to be as follows: Back roll iron, self weighted, two inches; middle roll iron, self-weighted, seven-eighths of an inch; front roll covered, the rolls on the two sides of the frame being weighted crossway with the same weight. Mules are generally made with all the rolls covered with cloth and leather, where there are two or more ends under each boss, but with a single end to a boss they are usually weighted on the front line only.

Upon combing and drawing frames the Messrs. Hetherington insert a strong spring between the saddle and the weight.

The importance of a uniform adjustment of weights, small grist and light pressure, seems to be fully recognized; and the general use of the coiler with the working up to the drawing-frame of a given number of *single* strands, is defended upon the ground that if many strands are carried to a railway head, they are there exposed to a draft upon a heavy grist and under an excessive weight, and that the fibres are impaired thereby.

In general it may be said that during the long battle of the spindles in this country, the attention of Lancashire men has been mainly devoted to selecting, sorting, mixing, cleansing, and preparing cotton for spinning.

On the other hand, the ring-frames now being constructed, with certain modifications which are claimed to be improvements, appear to be much more perfect in their construction

than those with which I was familiar of English construction six years and more since. The extreme perfection of the spindles proper, both in frames and mules, is very noticeable.

From my somewhat hasty observations I should infer that even greater care is now taken than there was six years since, when I visited Lancashire, in selecting, sorting, and mixing cotton, not with the view of using the best, cleanest, and highest priced for common work, but with the object of making the best use of the lower grades, and thus making a sufficiently good yarn at the lowest cost for the cotton.

In the card-room the grists are light; and what would be deemed slow speed even here has been adopted. Good, even roving having thus been secured, frames and mules are driven at very high speed.

Your yarn is made or marred before your stock reaches the front roll of the spinning-frame; and in the making of good yarn in the card-room your English competitors may have stolen a long march upon you while you have been discussing the weight and speed of your spindles. I do not mean to undervalue the improvements in spinning, but the department of sorting, opening, and carding, may have been relatively neglected.

OLD HOOPS UTILIZED.

A curious use is made of old cotton-bale hoops. They are worked or woven into grids, so to speak, and used to hold plastering, as we use wire lathing.

GAS-ENGINES.

Gas-engines appear to be taking the place of steam wherever small powers are wanted. The Otto leads, but the representatives of the Clark engine claim more continuous and uniform action. The latter is now made, or is about to be made, by the Goodwin Gas Meter Company, 1016 Filbert Street, Philadelphia. It is also said to be feasible to use rich oil-gas in these engines by the admixture of a large quantity of air at each explosion or stroke.

I submit herewith copies of the "Electrician," in which you will find a full account of the progress which has been made in supplying a non-illuminating gas for heating only, or for driving gas-engines.

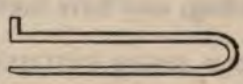
The Economic Motor Company, 28 Beekman Street, New

York, now offer a gas-engine a hundred and sixty pound weight, twenty-four inches high, occupying thirteen by eighteen inches floor space, consuming seven feet common city gas per hour, *half a man* power, for seventy-five dollars. I know nothing of the merits of their machine, but their proposal is prophetic.

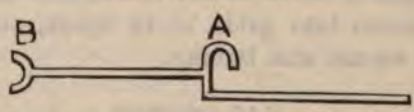
THE LANCASTER MULE-THROSTLE SPINNING-FRAME.

This frame is attracting much attention, but its success has yet to be proved in practice. Very soft yarn is being spun upon it in cop form upon a naked spindle. The cops are built upon a spindle such as is used in a mule, two-and-one-fourth inch gauge. The rings are three-fourths to one and a half inch. The peculiarity is in the traveller, which serves the purpose of a traveller, and also a purpose like that of a presser on a roving-frame. The ring-rail is double, with a small space between the two sections; and the flange which holds the traveller is vertical. The traveller is made of a thin film of steel.

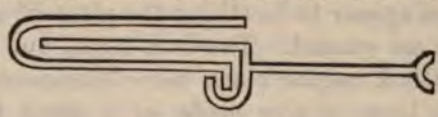
These sections merely give you the leading idea; they are not drawn by any scale.



SECTION OF RAIL.



TRAVELER MUCH MORE THAN THE REAL SIZE.



COMBINATION.

The thread is carried around the hook of the traveller A to the yoke B, and is by the latter guided to the cop. A more full description may be found in "Cotton, Wool, and Iron" for Sept. 15 and 22.

Mr. Lancaster was the inventor of the "slowing-down" motion on slashers, whereby a beam can be removed without stopping or altering the tension on the warp, and also of many other improvements in manufacturing processes. I am not

sure whether or not this slowing motion on the slasher has been introduced in this country. I was assured that it is now in common use in England, and is considered essential to the best work.

Since my return I have been somewhat amused to learn that a patent had been issued for a spinning-frame in which blocks of wood are interposed between sections of the iron frame in order to prevent vibration. You may remember that I made this suggestion when we were discussing spindle-bands some years since. In a fine mill in England I found some frames constructed in this way for this very purpose, and the owner justified the plan. It may be more necessary there, however, on account of the common use of iron beams in the construction of floors.

PRESERVING TIMBERS.

A method practised for this purpose is new to me. About three feet from the end of a heavy timber a hole is bored to the centre, into which a half-inch pipe is forced part way and wedged; creosote is then forced in with a hand-pump until the whole end of the timber is filled.

INSURANCE.

Nothing like our mutual system of insurance, combined with inspection and prevention of loss, exists. There is one large mutual insurance company, insuring factories and miscellaneous risks as well. Buildings and machinery are insured at different rates, and in many mills each department is insured separately at different rates. These rates are established at a certain tariff with special discounts for special appliances, but these appliances seem to me far less adequate and mostly inferior to our own. From many sources I obtained statements of the rates charged, which average substantially as follows:—

On first-class fire-proof mills the rate on the mill is about 5*s*., and on contents 10*s*. to 12*s*. 6d. per £100, or 50 to 62½ cents per $100; no rebate or return. On ordinary non-fireproof mills of average grade, 30*s*. to 40*s*. per £100, or $1.50 to $2 per $100. On old mills, which are very numerous, £3 and £4 per £100, or $3 and $4 per $100.

From these outside statements, and from data derived from underwriters, I am satisfied that the average rate on *fair* to

good non-fireproof mills, classed together, is more than *one* per cent, old mills omitted.

I learned one fact from the statistics of a very large insurance company, to wit, that their losses on cotton-mills last year were more than sixty-two per cent of their premiums, and the average premiums are higher than ours. This is for loss only, without expenses; the average expense of English insurance companies is about thirty per cent of their premiums.

I could get no accurate statistics of the per cent of loss on risks taken, and no absolute data as to the average rate of premium, but I am fully satisfied that the loss on textile factories is much greater than ours; that it was last year about twice and a half our average, and that the cost of insurance to the assured is nearly three times as great as it is under our system. But this opinion is subject to the reservation that a full examination would have required a long time, and that it is very difficult to get exact data.

I shall give attention to two subjects which I observed in London.

1. The light wooden structures, covering a large area, where a fire would expose the Albert Hall and the Kensington Museum to very great danger, were permitted to be built for the Fisheries exhibition, in view of their being protected with a fire-proof paint, which appears to be made of a combination of asbestos and silicate mixed without oil. It appears to be a penetrating and durable wash rather than a paint. It was subjected to the most severe tests before the warrant for the buildings was issued. Since this was written I have received samples and find that this paint consists only of silicate of soda and clay, — good for an inside wash, but of no permanent use outside.

2. A new substance just invented was presented to me. It is made of pulp of any kind — old newspapers and the like — converted by chemical treatment into a sort of leather-board, which is tough, flexible, apparently durable, very cheap, waterproof and substantially proof against sparks or cinders. Belts made of it are run under water.

If these claims can be sustained it is the long-sought suitable covering for a flat roof, but the case is only a *prima facie* one. The treatment was disclosed to me confidentially, and it seems to me that there is a fair chance of success.

WEIGHING SCALE FOR A LAPPER.

The counterbalance consists of a large copper cylinder pierced with holes, into which as much thoroughly dry cotton is placed as is intended to constitute a balance for one feed upon the apron of the breaker lapper. If changes in the atmosphere affect the cotton which is being fed, the cotton in the counterbalance is subject to the same conditions, and therefore the feed is kept up with greater uniformity than if the counterbalance were of metal.

APPARATUS FOR SPINNING A PORTION OF A BROKER'S SAMPLE.

Messrs. J. Hetherington & Sons now make a small set of machinery by means of which a common sample of cotton, say of fifty to one hundred bales, can be converted into yarn, and its strength and working qualities can be tested in two hours.

A schedule of this machinery has been furnished me, and is as follows: —

VULCAN WORKS, POLLARD STREET,
MANCHESTER, Oct. 11, 1883.

Estimate.

From JOHN HETHERINGTON & SONS.

To EDWARD ATKINSON, Esq., Boston.

1 Carding Engine, 40 in. on the wire, with main cylinder 50 in. diameter, doffer 24 in. diameter, taker-in 9 in. diameter, with 105 revolving flats; these flats to be planed on both edges, and the elastic bands accurately trued up with our patent truing apparatus, including coiling motion, under-casings of tinned iron, angle bars beneath cylinder and taker-in, circular brush with 4 rows of bristles, pulleys and set-hoops for cleaning the flats. Mote knife with brackets below the taker-in, and taker-in covered with metallic filleting, also Ashworth's patent grinding apparatus for truing up heel of flats . .	$465 00
1 Set of Card Clothing to suit the above card	180 00
1 Drawing Frame, 1 head of 2 deliveries, with 4 rows of rollers, 18 in. gauge, coiler and cam revolving motion, back and front stop motions, polished cast-iron turn-over clearer flats for stationary cloth, including our patent spring weight-hooks for front line of top-rollers and single preventer rollers at back .	187 00
1 Slubbing Frame of 30 spindles, ¾ in. diameter, 10 x 5¼ in. bobbin, 3 rows of rollers 20 in. gauge with 4 spindles single contrifugal pressers, including polished cast-iron turn-over clearer-flats for stationary cloth, long collars, loose boss-top rollers on front line, and hand indicators	531 00

1 Roving Frame of 56 spindles, 5/8 in. diameter, 7 x 3½ in. bobbin, 3 rows of rollers 20 in. gauge, with 8 spindles, single centrifugal pressers, including polished cast-iron turn-over clearer-flats for stationary cloth, long collars, loose boss top-rollers on front line, and hand indicators	$565 00
1 Flier Throstle-Frame of 32 spindles, 2 in. left, 2⅝ in. gauge or distance from centre to centre of spindles, 3 rows of drawing rollers, spindles driven by bands from single tin cylinders, and creel complete	200 00
1 Yarn-Tester	43 00
1 Wrap-Reel with scale weights	66 00
2 Thermometers, one dry and the other wet bulb, with the printed tables to give the humidity of the air whilst the experiment is being made	
Total	$2237 00

The above prices are for delivery f.o.b., Boston, exclusive of duty.

In this connection it may be added that for accurate work it is considered necessary to operate a yarn-tester with a steady power — no tests made by operating the machine with the hand being considered of much value.

If the plan for a textile laboratory which I shall present to you is adopted, a complete set of American machinery should be placed alongside such a set of English machinery as is included in the above schedule, and then by accurate observations of the two methods a final determination could be reached as to which is best. I am sure Mr. Draper would never permit an English frame to be set up as an instrument of instruction without putting the best Sawyer frame alongside of it, and I may be permitted to guess that our apparatus for such work as I shall submit to you presently will not cost us very much.

Professor Lanza proposes to use textile machinery as a part of his apparatus of instruction in the department of mechanical engineering in the Institute of Technology. If a complete set of machines is furnished to the Institute, it occurs to me that the study of cotton and other fibres mechanically and with the microscope, camera, etc., together with many experiments in dyeing, drying, etc., may be carried on at the Institute, for which there is little opportunity under the constant working pressure of a mill.

LORD'S FLIER THROSTLE.

Messrs. Lord Brothers have perfected a throstle spinning-frame with a light flier fitted for very high speed, some parts of the

design based on high-speed ring-frames. A production of five skeins per day of No. 32 warp is claimed for it, of which I present a sample.

ELECTRIC LIGHTING.

Electric lights have been adopted in factories in much less measure than with us. The art seems to be making little progress because of the incubus of innumerable patents and the failure of an enormous number of speculative companies. It is to be hoped that we may avoid some of the latter dangers, but the speculative advertisements of some of our companies in this section may, perhaps, indicate the usual course, a new crop of victims being apparently ready to swallow any specious bait which is dangled before them under the name of "treasury stock" and other devices for misleading the ignorant or the unwary.

TEXTILE MACHINERY.

An exhibition was opened at Oldham, Aug. 1, to remain open four months, in which I found the most complete collection of cotton machinery I ever saw, and it is said to be the best one ever made.

There is another exhibition at Huddersfield, which contains a full collection of woollen as well as cotton machinery.

In view of the alleged difficulties in obtaining entrance to English mills and works (which I did not meet), these two exhibitions offered a most excellent opportunity for the examination of all the latest improvements, which are not kept private or for the use of private owners. One or two such private inventions I was allowed to see, but am not permitted to describe.

I greatly regretted that I had not some one with me at these exhibitions who would have been better qualified to observe minor differences in the details of machines, and who might have observed many points which have probably escaped my notice.

With this I end the subject assigned to me, having recast for your use the report which I made to my directors on the thirteenth of September, which happened to fall into the hands of one of your officers, and brought to me the very flattering request that I would submit it to you.

My observations in Europe, and the thoughts which have been suggested in correcting this report for your use, have led me to venture upon trying your patience a few minutes longer, in order that I may submit to you a plan for a Textile Laboratory and Museum.

We can do all that they are doing in Europe and yet better. There is nothing in Europe yet of the nature of a complete Textile Laboratory. There are various departments, weaving schools, and the like, but I have ventured to prepare a plan for a Textile Laboratory and Museum, which I submitted the other day to Sir Lyon Playfair, whose experience in managing print works, and his experience as a teacher, render him an admirable judge. He returned it to me with scarcely any amendments. He says that when we shall have established such a textile department in this Institute of Technology, it will place this school in the position of the best school in the world. That plan I propose to submit to you this afternoon, in order that it may go upon the record, with certain suggestions in regard to the way of establishing it.

[At this point, Mr. Atkinson exhibited several samples of cotton — Surat, Egyptian, and others, — in which, he said, he thought the members might be interested.]

Before sitting down, as some of you will go to the fair, and as all new things ought to have attention called to them, I call attention to a machine which is in the New England Fair, for saving from eighty to ninety per cent of the cop waste by re-winding.

I brought home with me two pieces of cloth, singular in this respect, that, although they come from Great Britain, there is no sizing in the fabric, no starch in the warp. One has been subjected to a slight process of bleaching. They are made from Egyptian cotton, No. 42 combings, double twist, and No. 22 for the filling; and while they do not show remarkably good work, they show very remarkably good fibre. I thought you might be interested to see an English fabric of a very fine order which absolutely contains no sizing at all.

That is the sum and substance of my English experience, which is submitted to you for what it is worth. (Applause.) I should say that I had only about two weeks and a half for these investigations. I devoted myself mainly to leaving off twelve pounds of flesh, and adding twelve years to my life by having a

good time. I did not do much work for you or anybody else; but when I did get at work, after my passage by steamer was engaged, I was sorry that I had not three or four weeks more to devote to it. These are the results of a hasty observation of about two weeks.

Afternoon Session.

The members of the Association re-assembled at the hour appointed, and the President said: —

Gentlemen, if you will come to order and give your attention, Mr. Atkinson will resume his remarks.

Mr. Atkinson. I spoke this morning of a preliminary report upon the lubrication of heavy bearings. Accompanying that report is a thoroughly exhaustive treatment of the subject of covering steam-pipes. This document is to be circulated among the members of the mutual companies next week. I think, however, that the report upon steam-pipe coverings is one that you will desire to have perpetuated in the report of this meeting for permanent record, and I shall place it at the disposition of the Committee, to be so incorporated if they see fit to publish it. I think that Professor Ordway has probably knocked on the head about two-thirds of the steam-pipe coverings, and has, in all probability, presented to you rather a new form which may be as good, if not better, than any others. Our directors, who have looked over the proofs, regard this as a very important document, and I think you will desire to perpetuate it in your record. It will be placed at the disposition of the Secretary, to be included or not.

I spoke also this morning on the subject of rope belting, as being more desirable to underwriters than leather belting, on account of its freedom from water damage. I have been requested to call your attention to this belting made in Philadelphia by the Machine Belting Company, with which I think Mr. Barker and others have had some experience, which would be more free from water damage than leather, and which appears to be a very strong and durable substance. I know nothing about it myself.

I also desire to call your attention to a method of joining leather belting, which is perhaps worthy your attention, but of which I know but little.

It seems to me that all these new things may well be presented at this meeting for what they are worth, and I have no

hesitation in calling attention to them. That belting, if as effective as leather belting, would be, of course, more desirable, to the underwriters, because it would neither be subject to damage by water nor by extreme heat.

[Mr. Atkinson exhibited specimens of the several articles to which he referred, which were passed around among the members for their examination.]

I referred this morning to a plan which I had devised for a Textile Laboratory and Museum. I hope I shall not be considered intrusive if I develop it to you. It has grown out of my observations abroad, and has been developed in my own mind in the course of the preparation for this meeting, and therefore really forms a part of it. It will take me less than thirty minutes to present this matter. The great point is to get it upon your records, and to get your assistance in carrying it out.

My suggestions for the establishment of this Laboratory may at first thought appear to you to be somewhat visionary, but I shall ask you to submit them to a committee, to be reported upon at a future meeting.

You all know how dangerous it may be for you to try experiments in running your mills; how necessary it is for you to be cautious and conservative in respect to new ideas; how essential to profit that you should devote yourselves mainly to making the largest product at the lowest cost, according to accepted and long-tried methods. I am well aware how much a man risks who permits himself to become known or notorious as a theorist, and no one can be more cautious than myself in trying experiments in underwriting, which is now my business; but upon these questions of manufacturing I can submit as many audacious proposals as you are willing to listen to, and the responsibility rests upon you if you dare act upon them. Remember, if you please, that one whose only experience in manufacturing has been in the treasurer's office, can only deal with these questions theoretically and at arm's length; but also bear in mind that unless the so-called practical man fully comprehends the *true* theory of the art which he practises he may never become a master of it, no matter how successfully he may work at his vocation.

The very purpose of all the work which is done in this Massachusetts Institute of Technology, is to combine a mastery of

the theory of all the arts with such practice in our various laboratories as will render our graduates familiar with the working processes of as many branches of industry as can be taught in a laboratory in a thoroughly scientific way. We do not teach trades, but we try to give a solid groundwork in the theory of all the trades.

We now have the beginning of a weaving school, and, as I have previously told you, Professor Lanza intends to make use of textile machines as examples of mechanical work, and as instruments of instruction in mechanical engineering. The mule-head lends itself admirably to the purpose of instruction in this department, irrespective of its special use as a spinning-machine, because of the varied motions which are combined in it, and which it must impart. The Mason Machine Company have promised to prepare the best possible example of a mule-head for our use. We now possess looms which have been given to us by various makers. We have also a small drawing-frame with all the rolls weighted with scale-beams, in such a way that the finest adjustment can be measured, and the effect of light weight and heavy weight upon the rolls can be scientifically examined. This was given to me many years ago by the Saco Water Power Machine Shop, with the understanding that when the Institute could make use of it, it should become their property, and it now is. We have several small spinning-frames which were used in our tests of oil, and we shall procure other machines to make up the complete set when we have room to place them. But must we not do yet more?

When it is suggested to you that there may be a *Textile Laboratory*, to which should be added a Textile Museum, adjacent to our shops, in which the mechanic arts are taught, and next to the Industrial Chemical Laboratory which we intend to build as soon as we have the means, do you not at once ask yourselves how can we get along without such an aid to our work? Why has there not been such a laboratory before? Where else can purely scientific work in the treatment of cotton, wool, flax, and other fibres be done? Where else can the microscope, polariscope, and the camera be applied so effectively? Where else can the cause of the depreciation of the fibre of cotton in the processes of carding and drawing, and in the processes of dyeing and drying, be so surely discovered and perhaps remedied? Is it possible for you to conduct scientific researches,

which are now so much needed, under the daily pressure of the work of your factories? Where else can the hundred and one patent devices which are thrust upon your attention be subjected to an impartial trial? Where else than in such a laboratory can the ginning of cotton be considered in such direct connection with carding and spinning? (I received lately samples of cotton from a gin to which an *improved* steel brush had been applied, and by it the cotton had been improved (?) into an almost valueless condition of fly waste.)

Let me recall to your mind one or two things which have been already accomplished in these institute laboratories. It became necessary for the underwriters to know — not to guess, — but to know something about oils, their properties and their dangers. What did we really *know* about oil for lubrication when this subject was first taken up? In fifty-five of your mills, which might all have been running on the best and safest oil in about the same proportions as to cost and quantity, your practice varied from a cost of sixty-eight cents per thousand pounds of cloth to $\$2\frac{58}{100}$, and your quantity from $1\frac{3}{100}$ to $2\frac{89}{100}$ gallons per thousand pounds. Why was this? Because few or none had mastered the theory of lubrication until Professor Ordway, Mr. C. N. Waite, and our inspector, Mr. Woodbury, by their joint investigation laid their scientific groundwork, upon which a true theory could be predicated. We learned the causes of danger from your practical experience, but both the remedy of that danger and economy in the lubrication of your machinery could only be determined after a long and exhaustive study of this theory, coupled with months of practice on special machines of the utmost precision, and an amount of scientific work which could only be done in a laboratory of chemistry and of mechanics combined.

Many of you, all who are members of the mutual companies, will soon receive a report on the lubrication of heavy bearings, giving the latest results of Mr. Woodbury's tests; and also Professor Ordway's report on steam-pipe coverings. Are these documents of sufficient value to be made permanent in your record of this meeting? If so, I beg to present them and to place them at your service. By what little has been done may you not measure what remains to be done? In our work as underwriters we cannot avoid observing, even if we would, many points of difference in the practice of various mills, upon which

we must keep silent if they do not affect our risk, lest we should carry trade secrets from one to another. But we also know that there are many general branches of your work and of that of your associates in the woollen-mills, which are, almost without exception, rude in the extreme, and upon which there appears to be as little positive knowledge as there was in respect to lubrication and the covering of steam pipes until very lately.

I will name — 1st, the art of drying fibres and fabrics; 2d, the effect of high and low degrees of heat upon fibres and fabrics; 3d, the art of oiling or smearing wool; what oil, what compound, or what substitute is best for this purpose appears to be absolutely undetermined; there is as much evidence that all are bad as there is that any are good; 4th, the effect of greater or less humidity upon the various processes of manufacture, that is, the "dog-day" question. Witness the discussion which has taken place to-day upon the difficulties which occur in working your mills in the dog-days.

I have ventured to prepare a report upon this discussion in advance, and I will now read it exactly as I dictated it on the fourth day of October last.

It has appeared that there are certain troublesome effects of dog-day weather which affect nearly all cotton-mills alike; but their precise nature still remains obscure. It has not been determined whether the adverse effect of dog-day weather is only upon the fibre, — upon the top-roll covering mostly, — or upon the spindle-bands in greatest measure. It has not become apparent whether one locality is affected more than another, and no adequate remedy has been proposed.

May not all these points be studied, and perhaps determined in a textile laboratory, where an artificial atmosphere can be prepared, varied, and measured, in dryness and humidity, for this purpose only? Can these questions be settled in a factory under the pressure of the bad work which keeps everybody more busy than usual when the dog-days are upon you?

I have named a few subjects which have often been matters of discussion in our office, among our corps of inspectors. Some of them are directly connected with danger of fire, notably drying and oiling wool. But there are many other subjects of paramount importance which we are not called upon to consider, which are equally crude. One only need glance over the columns of question and answer which appear weekly in "Cotton,

Wool, and Iron," to prove want of exact knowledge, unless a large portion of your number are unwilling to communicate what you know, either in these meetings or elsewhere. Upon some of these matters there must be very little accurate and positive knowledge in respect to almost vital questions in the treatment both of cotton and of wool.

I suspect that there are still a good many men who think that they can keep general conditions of superiority locked up inside their own mills, by keeping their doors and their mouths shut; that special trade secrets may be so kept is, of course, admitted, but even some of these most precious secrets are not infrequently old and discarded in other places, while the attempt to maintain general superiority by secrecy, reminds me of a story about the late Edward Harris, which he himself assured me was true, and which he explained.

The story was this: A very prominent member of a Boston commission house, selling goods for one of the largest woollen mills, to which entrance was invariably denied, suggested one day to the agent to visit Harris's mill and try to find out how it was that he beat them so much in making cassimeres! The agent went to Woonsocket, and was cordially received by Mr. Harris, who at once took him all over his mill. On his return to Boston, the principal of the house said to the agent: —

"Well, Mr. B., what did you find?" to which Mr. B. answered, —

"I found that we had kept our mill-doors so closely locked that we had shut all the modern methods and improvements *outside*."

I asked Edward Harris if this story was true, and he said it coincided with what the agent told him he should report. "Then," said I, "on what principle do you let all of your competitors go through your mill?"

"Oh," said Harris, "the principle is simple enough! I always go with them myself, and I always find that any fool can teach *me* something."

I think, gentlemen, that if some of our wise but over-silent men in this Association would go with us over the mill as we discuss its departments here, and be as free with their knowledge as Edward Harris was with his, they would soon find a benefit even to themselves.

The art of treating cotton and wool is not exhausted; on the

contrary, the wisest of us cotton men are only in the next class above the primary; and in wool and worsted there are only a few who have yet got out of the alphabet. We can all profit by truly scientific discussion, and the one thing most needed in this country is a truly scientific preparation for the textile arts. I think I hear some of our woollen friends using a few strong expressions at my putting cotton men in advance of them; but they will not be out of the alphabet until they agree on a few of the first letters, such as oiling wool, on which they are now all at odds.

If Dr. Bowman is right, as he doubtless is, in his statement that we can find but one-fourth or fifth part of the normal strength of mature cotton fibres in the best yarn, is there not a large margin for scientific research? Is not the true theory of carding and spinning yet to be formulated and made plain?

In this close competition of modern times, when all profit or loss turns on a small fraction of a cent in each or all departments, can you now afford to be without a textile laboratory, where all these obscure questions may be investigated without regard to any immediate commercial benefit to those who do the work, and in order to establish a true theory upon every point? I tell you that you cannot rest. We have done well in the Institute of Technology in our instruction of the higher branches of technical science, but in this every-day work of technical instruction in the art of spinning, weaving and dyeing, all Europe is ahead of us, perhaps by only a few years.

I have seen the great foundation for technical instruction in all branches of science which the German government is establishing at Strasbourg; perhaps in order to reconcile the manufacturing district of Alsace to being incorporated in the German empire. I have seen at Crefeld, in Prussia, a building as large as either of these of the Institute, which is to be wholly devoted to weaving and dyeing. I have seen the technical school at Bradford, which is to be devoted exclusively to the art of manufacturing, dyeing, and finishing what are known as "Bradford goods." In England, where the beginning was only lately made, there are already fully developed schools for technical instruction in particular arts, at Bradford, which I have named, at Batley, at Glasgow, at Leeds, and I believe at Huddersfield, and in construction at Manchester. At King's College in London, there is the opportunity for the most adequate

instruction in science. You will concur with me in the absolute conviction that there can be no delay in enlarging our work of instruction in this country. I therefore ask you to appoint a committee to consider and report at a future meeting upon this whole subject, and I suggest that this paper be referred to them. This practical committee can determine how much work can be done in a suitable way upon a small but complete set of cotton, wool or flax machines; whether or not it is feasible to spin yarn in a small way that will serve as a standard for examination, as well as yarn made in the usual way in the regular production of a mill. But it needs no such committee to indicate to you how far the experiments with the microscope, the polariscope, and the camera can be carried in such a laboratory beyond the possibility of their use under the pressure of the regular work of the mill. To such a committee I desire to submit this *theory* of a complete textile laboratory. I do not wish to be placed on that committee myself, because I may represent the Institute in working with them to the same end. I therefore hope that some other member who is interested in this subject will make the motion.

The matter to be considered on the part of the Institute will be to determine what can be done in making use of a textile laboratory as an instrumentality in the general scientific training which it is our purpose to give. It is necessary for us to avoid becoming in any substantial measure the teachers of specific trades, but we may make our general work consistent with practice in the textile arts, in just such measure as the philosophy of the textile arts forms a part of instruction in applied science.

Such a beginning on a broad basis will surely lead to the establishment of special trade-schools in our factory towns. It will not be many years before Lowell, Lawrence and Manchester will have textile schools. Holyoke will have its laboratory of paper-making. Connecticut will have its special schools in brass and other fine metal-working. In this way, and in this way only, will New England be able to maintain her supremacy in competition with other parts of our common country which are more richly endowed by nature.

I have no authority from the Institute of Technology to present this subject on their behalf. It will be a matter of as grave consideration on their part as it will be upon your own.

But I can imagine a department of the Institute of Technology organized with reference to a degree in the special department of textile industry which would stand equal in every respect to our special courses in architecture, engineering, or chemistry.

Assume for a moment, if you please, that the pupil has passed the first two years in the usual course, in which the studies are alike in nearly all the departments, and that he now elects to become a student in the department of textile industry, and think what a field is opened by this suggestion. First would come a study of Physical Geography, Geology, and Natural History, and the Chemistry of Soils in relation to all vegetable fibres and to all animals which yield fibres to the textile arts. Next would come the physical study of the fibres themselves with the microscope, the polariscope, and the camera. An examination of all kinds of cotton, — all kinds of wool, — all kinds of flax, hemp, and silk; what a foundation might here be laid in the art of sorting wool; the science of wool may well precede the art of sorting. Next would come the study of the manufacture of all textiles, historically and mechanically. Then the fundamental principles of all the machines which are in use, with laboratory practice in the art of carding, spinning and weaving. The professor of architecture would be called upon to give lessons in mill construction. The professor of underwriting might be called in to aid with a special course, and might perhaps teach something more than the art of saving property from fire. And finally the professor of political science would treat the condition of the operative, and historic changes which the introduction of machinery have made in the condition of the people of all lands. In short the professor of every science would be called upon to do his best in the instruction of students in the textile department in order that they might be well qualified to take their degree and enter upon the work of life as well equipped as they should be.

Is there any reason why the study of the art in which a man is to employ his working life, and by which he is to sustain himself and others, should not be made use of to develop his own mind; will he not take a greater interest in such a study, and develop his own capacity more fully than he will in the study of something entirely foreign to this purpose? Is a study less fit as an intellectual exercise because it is useful in a material sense?

I suggested at the beginning that the scheme might be deemed visionary, but I have convinced myself, if no one else, that it is one of the most practical and common-sense propositions that I have ever submitted to you, in which conclusion I hope you will all concur.

The machinery required for instruction in each fibre (which at the beginning might be cotton, wool, and silk, omitting flax) might be one set of machinery, to be kept well adjusted for carding and spinning; one set to be thrown out of gear in order that the work of adjustment might be done by the students, and one set to be taken apart and set up from time to time. In respect to cotton, one full additional set of English machinery would be needed.

How many series of three sets each would be needed in each department would, of course, depend upon the number of students; but it is not probable that more than one series of each kind could be used at the beginning, while the building might well be constructed with a view to future additions.

In a rough-and-ready way it might be said that three floors, each 72 x 100, would be adequate for both the laboratory and the museum, but the construction should be such as to permit the raising of the roof, — by so doing and moving the textile museum to an adjacent building, the space first assigned to machinery could be afterward doubled.

All these details are, however, subject to full consideration by the proposed committee.

Having submitted a draft of a course of instruction in textile industry to Sir Lyon Playfair, he has returned it to me with such amendments as he deemed suitable, with the following note, which I am permitted to publish.

It is with great satisfaction that I submit such an unqualified approval of the general features of my plan, from one whose scientific attainments and world-wide reputation makes him an authority of the highest order; and I may be permitted to take a little personal satisfaction in the fact that Professor Playfair found it necessary to make very few amendments to the ideal course of instruction which I submitted to him for his criticism.

BOSTON, 26th October, 1883.

DEAR MR. ATKINSON, — I return you the MS. paper containing your proposal for providing a laboratory and museum to advance the interests of textile industries by an efficient practical study of them. The subject is not new to me, for at one time of my life I was manager of large calico print

works, as well as a professor of chemistry who bestowed much attention to the technical applications of his science.

Such an institution as you propose would in my opinion make the Institute of Technology of Boston the best equipped and most practically useful technical school in the world. I have visited almost every technical college in Europe, and I already place Boston very high as a place of technical education. If you get up this textile institution I shall have to take off my coat again and work for the advance of technological schools in England. Lately I have rested on my oars, and allowed younger men to pursue my former work. But I must begin again if Boston goes on at this rate, for though, as Wendell Holmes says, "that I am a citizen of Boston — on the female side," and I love it well, I love my mother country still more, and would not like to see it lag in the preparation of its youth for those textile industries which lie at the foundation of its prosperities. Wishing you well in you new prospect,

I am, yours sincerely,

LYON PLAYFAIR.

EDWARD ATKINSON, Esq.

PROPOSALS FOR A TEXTILE LABORATORY AND MUSEUM IN BOSTON, WHICH WERE SUBMITTED TO PROFESSOR PLAYFAIR, AND AMENDED BY HIM.

The annual value of the textile industries of the United States already amounts to more than six hundred million dollars, and that of the imported products to more than one hundred and twenty-five million dollars. For this great industry there is no special training of the youth who intend to prosecute it. Efficient practical courses of instruction might be carried out at the Massachusetts Institute of Technology if a well-appointed building, provided with textile laboratories and textile museum, were erected for the purpose. The first two years' course of instruction in the Institute is admirably suited as a basis for the future special study of textile manufactures, and it is in the next two years of the curriculum that special training should be followed. The first two years would ground the student in modern languages and mathematics, — in mechanical drawing: in general geology and chemistry as well as in the practical work of the physical and chemical laboratories, and will thus prepare him for entering upon the special course of textile industry.

The foregoing computation of the value of the textile industries is given for the domestic fabrics at the factories, and for foreign fabrics without duties. If the cost of wholesale distribution and the duties be added, the wholesale value of textile fabrics used in the United States to those who con-

vert them into garments is, in round numbers, eight hundred million dollars. About one-eighth of this quantity consists of carpets, hosiery, embroideries, and other goods of like kind which are ready for the consumer: perhaps an equal quantity consists of silks and fine fabrics of various kinds, which are more than doubled in value by the addition of the supplies used and the labor put upon them by those who convert them into garments. About seven hundred million dollars in value consists of the useful staple goods which are used by the million. Some time since I had occasion to investigate the value of woollen and worsted cloth when converted into clothing, and the value of cotton goods when converted into shirts and other common garments. In each case I found that the clothier, the shirt-maker, and others who consume these goods, about doubled their value by the addition of supplies and labor thereto. In a rough-and-ready way it may therefore be said that the value of the clothing of the people of the United States, ready for final distribution to them, is fourteen hundred million dollars; and if to this sum be added the carpets, hosiery, laces, etc., first named, the total value of textiles used in the United States when made ready for the consumer is *fifteen hundred million dollars a year.* This is, I am confident, a very close approximation. The department of textile industry now proposed would lie at the foundation of this immense superstructure. Ought it not to be solidly established?

The professional studies might then be substantially as follows, covering two years: —

1. *Geology*, specially applied to the formation, distribution, and character of soils, and also as to their disintegration and preparation for culture. *Physical geography and climatology.* These subjects would be studied with reference to the production of animal and vegetable fibres.

2. *Economic Natural History and Botany of Plant and Animal producing Fibres.* — Laboratory practice in sorting wool, stapling cotton, and conditioning silk.

3. *Applied Physics.* — Laboratory practice in the use of and application of the microscope, polariscope, and photography to fibres and fabrics.

4. *Mechanical Engineering.* — The use in and application of steam, water, and electric power to factories — shafting, belting, etc.

5. *Building and Architecture.* — Special study of the construction of factories; prevention of fire; vibration as affecting the wear of machinery, the health of the operative, etc.

6. *Mechanics.* — The theory of all machines which are used in the textile arts, with laboratory practice in preparing, carding, spinning, and weaving fibres.

7. *Textile Design in all Branches.* — Special instruction in the preparations of designs suited for different materials. Laboratory practice in the art of engraving copper rollers, as well as wood-cutting for printing, and also in the art of weaving.

8. *Industrial Chemistry.* — Laboratory practice in the preparation and use of mordants and dyes; in the various methods of bleaching, and in the discharging of colors; in the preparation of the cloth for the various processes of dyeing and printing.

9. *History.* — The connection of the textile arts with the history of nations, and of the causes which have led to their rise and decline in relation to special industries.

10. *Political Economy.* — The connection of the textile arts with the condition of the people of various countries; to which might well be added a few lectures on business law, forms of contract and the like.

Textile Museum. — A complete textile museum, such as now forms a part of the apparatus of instruction in the weaving school in Crefeld, Germany, would be essential to our complete success. It may here be observed that many of the students who attend the Crefeld school intend to become merchants, and they take the course of instruction in weaving and dyeing in order to qualify themselves to be intelligent judges of the quality of goods.

Dye-House. — A small but well equipped dye-house would be needed, unless the Laboratory of Industrial Chemistry, which will by-and-by be constructed, should prove adequate to the purpose.

No branch of industry has been more benefited by the work which has been done in the Institute of Technology than the textile arts; yet, with a few conspicuous exceptions, our gifts and bequests have been mainly derived from other sources. Now, although it is open to any one to perpetuate his name by a full endowment of this proposed textile laboratory, yet it

would be more desirable, in order that all the textile contributors might have a personal interest in the undertaking, to obtain a large number of small subscriptions than to provide the means by single subscriptions of large sums. I have said that I present this subject upon my own responsibility, and without any specific authority from the government of the Institute, yet I doubt not they will find the land if the requisite means are furnished to construct and equip the building. For this purpose $50,000 would probably barely suffice, yet such a subscription would warrant a beginning. I think $100,000 would be ample; after that contributions to sustain the teaching force might fall in from time to time as the course of instruction justified itself to the community. Now, only think of it, five per cent upon a single average annual dividend made by the mutual insurance companies to their members would serve adequately for this purpose. In an average year we return to the members of the mutual insurance companies more than $2,000,000, which is absolutely saved to them by our methods, or, I should say, by their methods of employing us to do the work of preventing fires. In this work I have found the service of the professors of the Institute and the use of its laboratories almost indispensable, and I can safely assure you that this service which the mutual underwriters, and through them the members of the companies, have received from the work done in this Institute has been and is worth five per cent upon the dividends in each and every year.

You are familiar with the reports which have emanated from this source; but you do not know what I now tell you, that there is scarcely a week passes without it being necessary for me to submit here some questions to be answered or some substance to be analyzed, upon which the safety of your premises greatly depends. May not these services, which have been rendered in the past, with the promise of yet more in the future, render it perfectly suitable for every one of the corporations which you represent to make a contribution to this textile library.

There are 900 members in all the mutual insurance companies, of whom three-quarters are textile manufacturers. One hundred contributions of $500 each or more, and five hundred contributions of $100 each or less, the surplus over in one class balancing the deficit in the other, would enable us to notify you

to hold your very next October meeting in the Textile Laboratory Building of the Massachusetts Institute of Technology.

Aside from the interest of our corporation, have we not a personal interest of our own in this matter either for ourselves or our children, sufficient to induce us to promote it by our contributions? I will be one of the hundred first named to contribute; who will join me now and here? I have prepared subscription papers with the intention of sending a copy of this plan with a subscription paper to every treasurer, agent, or other person represented upon the list of members of the mutual insurance companies. Will you, each of you, take your copy of the subscription paper now, and within the week send to me the list of the subscriptions which you can obtain?

I now have the hope of such a response as will authorize us to begin our work of construction as soon as the weather will permit us to drive the piles next spring, and if you will second me, as I think you will, my hope will be converted into a solid conviction. With such a committee as you have appointed, and in view of the hearty approval which you have manifested, I shall then feel that our success will be absolutely sure.

TEXTILE LABORATORY AND MUSEUM.

The subscribers agree to pay the sums set against their respective names, provided the total subscription shall not be less than fifty thousand dollars, — for the purpose of enabling the Massachusetts Institute of Technology to construct and equip a Textile Laboratory and Museum, and to establish a course of instruction in the Textile Arts therein, substantially in accordance with the plan submitted by Edward Atkinson at a meeting of the New England Cotton Manufacturers' Association, held in Boston, Oct. 31, 1883.

Mr. GARSED. Did I understand Mr. Atkinson to say that the textile manufactures, when made up in this country, amount to thirty-two dollars per head for the entire population of the United States?

Mr. ATKINSON. Yes, sir. I have tested that matter in two or three different ways. The cotton census was one of them. I proved it by the commercial crop. I accounted for every bale of cotton within ten thousand. I knew the wool census was right, and I have reason to believe that the other censuses of textile manufactures are correct. The annual value as given by each census amounted to over six hundred million dollars, which was the value at the mills. The imports of the year

ending June 30, 1881, were one hundred and twenty-five million dollars. Add the cost of wholesale distribution, and add the duties, and you have eight hundred million dollars.

Now, some time ago, I desired to know what was the annual value of the products of the United States. I took this method: I took the cotton crop and credited it with the export; then converted the rest, through the factory, through the upper stories of the retail stores of Boston, into goods, and found out what it cost people for cotton goods, in a very close approximation. I then went through woollen in the same way. I have taken wheat and carried it through into bread. I am now at work on beef. The only way to arrive at a close approximation of the value of the annual products of this country is to take these great staples and follow them through from the field to the consumer. And the startling thing is, that in respect to food, surely one-third, and probably one-half, of the entire cost of food to the poorer classes in the cities consists in the expense of the retail distribution. It costs more in this city of Boston to get the bread from the mouth of the baker's oven into the mouths of the people who eat it, than it does to bring it from Iowa, grind it, manufacture it, bake it, and deliver it at the mouth of the oven. It is in the direction of teaching the common people how to earn, by carrying this technical instruction into the common school, so that hand and brain alike shall be trained to the necessities of life; how to spend, by dealing for cash with the shops that on large trade make small profits; and how to save by cooking their food after they have got it into their houses. There is a kind of philanthrophy that pays, and this textile laboratory lies at the foundation of that kind of philanthropy, and that is what makes it worth following.

A Member. What is the gross sum of money called for to carry out your plan?

Mr. Atkinson. A hundred thousand dollars: a hundred subscriptions of five hundred dollars each, or more, and five hundred subscriptions of a hundred dollars each, or less. I want a large number of small subscriptions, in order that every man shall feel that he has a personal interest there. Now, can you not do it? We have just raised two hundred and fifty thousand dollars among our friends for the memorial fund to William Burton Rogers, in gifts from twenty-five thousand dollars down to twenty-five dollars. That money has been put

in trust. We are developing in every way, and as fast as we can. The pressure for our work exceeds all our means. Before you go, step into the new laboratories in the next building. Don't mind the "No admittance;" go all over them; and to-morrow morning go out on the Providence railroad, opposite the Charitable Mechanics' Building, and look into the mechanic art-shops, and see what you find there. Go and examine the one-story factory, well fitted with tools. But we cannot begin to do the work which is pressing upon us to be done. We have done all that we can do. There is a list of the subscribers to the two hundred and fifty thousand dollars, raised in a quiet way, to the memory of our first President. Now I ask you to help me in getting a hundred thousand dollars more to place at the foundation of an industry amounting to sixteen hundred million dollars, the first laboratory in the world that shall be developed completely and adequately, and devoted to that purpose.

A MEMBER. What did I understand to be the amount of your subscription?

Mr. ATKINSON. I said I would be the first to subscribe five hundred dollars.

Mr. DRAPER. I will be the second.

Mr. LEIGH. I will give five hundred dollars' worth of machinery.

Mr. ATKINSON. Go on, gentlemen: this is a good beginning. This is not the proper place, nor hardly the proper time, to urge this matter upon you. I am going to place it squarely before you, and if you think it is not well judged, don't give a cent. Here are subscription-papers. I hope they will be carried away and returned speedily.

Mr. DRAPER. I move that the matter be referred to the Board of Government.

Mr. ATKINSON. I have asked for a special committee. Not that I have the slightest objection to the Board of Government, but I have suggested some names to the Chairman of gentlemen residing in different cities, and whose selection will lead to effort in certain directions.

Mr. DRAPER. I beg your pardon: I did not remember your suggestion. I will withdraw my motion.

Mr. ATKINSON. I make that motion, sir, — that a committee of five be appointed by the chair.

The motion was seconded and carried unanimously.

The President appointed the following gentlemen as the Committee: J. S. Ludlam, Timothy Merrick, George Draper, Charles W. Lippitt, John Kilburn, and George A. Chase.

Mr. ATKINSON. There is one man with us who is eminently qualified, both by practical skill, theoretical knowledge, and complete mastery of this subject, who may be added. I move that the President of this Association be added to that Committee. As many of you as are in favor of that motion will say "Aye."

The motion was carried, and the President added to the Committee.

The PRESIDENT. Gentlemen. the next subject for discussion is the one that was passed over in order that we might listen to Mr. Atkinson — the subject of double roving and high draft *versus* single roving and low draft. This question was discussed at some length at our last meeting in April, and was referred, or assigned, to this meeting. Is there any gentleman who can enlighten us still further upon that topic? I call upon Mr. Lippitt.

Mr. LIPPITT. Mr. Chairman, I presume it will be generally acknowledged among those who have given this matter much attention, that the benefits of doubling the draft and roving on frame filling are unquestioned. It seems to have made so great a gain in that part of the work that its advantage is beyond controversy. On warp, the gain does not seem to be so much. All the experiments of which I have had any knowledge have agreed in placing the gain upon warp as considerably less than that upon filling, although in most cases there has been a gain, and in some a very decided one. Some of the gentlemen may remember that at our last meeting I gave an account of some tests made at the Globe Mill in Woonsocket, and that at that time we found the gain on frame filling in the strength of the yarn amounted to about twenty per cent, and about forty per cent in the running of the work; while upon the warp the benefit was only about six per cent in the strength of the yarn, and perhaps nine or ten in the running of the work. This difference led us to make some further experiments there, the aim of which was to discover, if possible, in the first place, whether this difference between the advantage on filling and on warp was due to excessive draft; and, in the second place, to find out what would be the precise benefit of reducing the draft and

running the double roving in the ordinary way; that is, by making fine roving and running the same draft as on the single roving; and I propose to give an account of the tests which were made for that purpose.

We made some ten-hank roving; we had used formerly say five-hank. We doubled it both upon the filling and upon the warp. The filling was No. 35 yarn, and the warp, No. 33. On the warp, on No. 33, we got, with the fine ten-hank roving, a strength of 51.92 pounds; while with the five-hank roving, run double and double draft, we got a strength of 47.53 pounds, which made a gain of 4.39 pounds, or nine and a quarter per cent in the strength, by reducing the draft on the warp. On filling, with No. 35 yarn, the strength was 45.72 on the ten-hank roving, and 42.46 on the five-hank roving, making a gain of 3.26 pounds, or nearly seven and three-quarters per cent. So that you will see that by reducing the draft we got in the strength of the yarn about the same increase on both filling and warp: that is, the increase amounted to from seven and three quarters to nine and a quarter per cent.

I also have an account of some tests which were made in the same way at the Pacific Mills in Lawrence, on No. 28 warp yarn, with a twist of 25.48. I have the result of experiments on the strength of the yarn with roving run single, run double with a double draft, and run double with a single draft. The yarn averaged very nearly No. 29 on all the tests. There were one hundred and four tests made with each method of running the work. With single roving and single draft, they got 51¾ pounds; with single roving and double draft, they got 57.19 pounds, a gain of five and a half pounds. With double roving and single draft, that is, with fine roving, the strength was 62.73 pounds, or a gain of 10.96, nearly 11 pounds, from using double roving and single draft. This gave for the single draft a gain of 21.17 per cent, and for the double draft a gain of 10.42 per cent. So that you will see that the difference between the two, ten per cent, came very close to what our gains were from reducing the draft at the Globe Mill. That is, the gain from reduction in the draft seems to amount, on both warp and filling, to about ten per cent. So that I concluded, from the tests, that it was a fact that double roving, irrespective entirely of the draft we used, would make a very much greater gain on filling than on warp, and that I presume

is due to the twist, which on warp makes the fine places very much stronger than those in the filling.

There was one other point which we kept account of at the Globe Mill, and that was the running of the work; in other words, the number of ends that were broken down. We found that on filling, as I have said, there was a gain of forty-two per cent, and on warp of nine per cent, by using double roving and double draft. We found that upon warp, by reducing the draft, there was a further gain of sixty-two per cent in the running of the work. That is to say, the number of ends that broke down with five-hank roving run double with double draft, was thirty-two on warp, on one hundred and sixty spindles, while there were only twelve ends that broke down upon a similar frame where double roving and single draft were used. So you see that although there was a gain of only nine per cent in strength, the gain in the running of the work amounted to sixty-two per cent. I think if we could rely upon a gain of that kind by the same means, it would become a question whether we could not make cheaper goods even out of No. 28 yarn by using double roving and single draft than by running our work in the way in which it is ordinarily run. In fact, I have been told recently of a New England mill where, making No. 28 yarn, they have increased the hank-roving from four to six, running it double where they formerly ran it single on the frame, and in that way have increased the strength of the yarn from sixty-two to seventy pounds, and have decreased the cost of weaving from sixty-five to fifty cents a cut. I presume that, so long as the cost of weaving is so large a part of the entire cost of labor in a mill, as at the present time, such a reduction would pay a very handsome profit on the cost of the change.

We also kept an account of the evenness of the yarn; that is, after getting the average number, we found the difference between that average and the number from each reeling. On the various tests that were made, we found that it was invariably the case that double roving made more even yarn as compared with single roving, and that the low draft with the double roving made a more even yarn than the double roving with the high draft. So that the entire result of the test seems to have been that there was a gain, and quite a decided one, whether on warp or filling, from using double roving and double draft, and that there was an increased gain of nine or ten per cent in

the strength; and a very large gain, amounting, on the warp, to sixty-two per cent, and on the filling to forty-eight per cent, in the running of the work, by reducing the draft from what I call double draft to single draft.

I think that perhaps there has been some misunderstanding among certain people as to what is claimed for the double draft. There seems to be a disposition on the part of some to suppose that it is claimed that double draft, in itself, is a benefit, while, as I understand the matter, double draft is allowed by all parties to be an injury in itself; but inasmuch as it enables us to use a double roving, there is a greater gain from the double roving than loss from the double draft, and the gain from the former more than counterbalances the injury from the latter.

I have prepared these tables, and they give a great many details which perhaps it would take too much time to read, but if the committee see fit to print the tables, they will give information to those who care to go into the matter any further.

The following tables give the results of Mr. Whitman's experiments, numbered in four series, A, B, C, and D.

Series A shows the results of the test from twelve different spinning-frames, of the breaking strength of yarn under two conditions; one as it broke from roving from intermediates and fly-frames, which were geared at one end, and the other in which the two frames were geared at both ends. In this series, the intermediate gears, on the intermediate frames, were *below* the rolls, in both cases; in the fly-frames, they were *above* them, as usual. In this series the difference in the variation of strength is very noticeable, as follows:

SERIES A.

SINGLE GEARING.		DOUBLE GEARING.	
BEFORE.		AFTER.	
24.09	55.00	23.81	80.00
23.94	61.00	23.94	76.50
23.81	63.00	23.66	77.80
24.09	58.00	23.81	75.75
24.39	60.00	23.94	78.75
23.81	64.00	24.09	76.25
24.09	68.00	23.52	81.50
24.39	57.25	23.81	77.25
24.84	67.00	24.60	81.50
23.81	63.75	23.94	78.00
23.40	70.00	23.66	77.75
24.60	68.75	23.94	75.93
Av'ges, 26.105	62.98	Av'ges, 23.89	78.06
Var'n, 23.40 to 24.84	55.00 to 70.00	Var'n, 23.52 to 24.80	75.75 to 81.50

Series B shows the difference in strength produced by a change on the intermediate frame only, from gears at both ends, *below* the rolls, to gears at both ends, *above* the rolls, as follows:

GEARS BELOW.		GEARS ABOVE.	
NO. YARN.	STRENGTH.	NO. YARN.	STRENGTH.
23.81	70.00 lbs.	23.94	73.00 lbs.
23.94	72.00 "	23.66	76.25 "
23.81	74.00 "	24.09	75.75 "
23.66	70.00 "	33.66	74.50 "
24.09	72.25 "	24.24	76.25 "
23.60	74.00 "	24.09	74.75 "
23.81	70.50 "	23.66	75.25 "
24.09	72.50 "	24.24	76.00 "
23.94	75.00 "	23.52	76.75 "
24.09	71.00 "	23.81	75.25 "
23.94	74.00 "	23.66	74.75 "
24.24	70.00 "	23.81	75.25 "
Av'ge 23.92	Av'ge 72.104	Av'ge 23.865	Av'ge, 75.31
Variation 70 lbs. to 75.		Variation 73 to 76.75 lbs.	

The fly-frames in these trials had only gears at one end.

Series C gives the result of the trials made on another day, from sixteen frames, under the same conditions as Series B.

Break *Before.*		Break *After.*	
No.	Break.	No.	Break.
23.81	71.25	23.93	76.50
23.52	72.25	23.60	76.67
23.52	72.00	23.81	70.75
23.81	72.00	23.70	73.00
23.81	72.00	23.25	77.25
23.25	76.25	23.25	76.75
24.24	67.00	23.81	74.75
23.81	75.75	23.25	78.00
23.81	73.50	24.39	75.25
23.93	74.00	23.81	78.25
23.94	76.50	23.66	77.25
23.81	73.50	23.94	78.75
23.81	72.75	24.09	76.25
23.66	69.00	23.12	75.25
23.12	72.75	23.81	78.25
23.40	71.50	23.40	76.50
Av'ge 23.70	Av'ge 72.625	Av'ge 23.68	Av'ge 76.215

Series D shows the result of trials of Mule-filling, where the intermediate frame only had been *double-geared*, as follows:

Before Change.		After Change.	
No. Yarn.	Strength,	No. Yarn.	Strength.
34.18	33.25 lbs.	33.89	37.25 lbs.
33.33	34.00 "	34.18	38.00 "
33.89	35.00 "	33.89	40.00 "
34.78	33.50 "	34.68	39.25 "
36.33	34.00 "	36.68	37.50 "
36.03	34.50 "	36.68	38.75 "
35.71	35.25 "	35.53	39.75 "
35.71	34.75 "	36.03	39.25 "
Av'ge 34 99	Av'ge 34.28 lbs.	Av'ge 35.195	Av'ge 38.72 lbs.

GLOBE MILL, WOONSOCKET.

Date of Trial.	Roving.	How Run.	Draft.	Kind of Yarn.	Less Broken.	Average No.	Average Strength.	Ends Broken per Doff.	Average Variation per Lea.	Gain of Double Roving. Strength.	Ends Broken.	Variation.
May, 1881,	5 hank.	Double.	14.62	Filling.	60	35.52	39.50	58	.85			
" "	"	Single.	7.31	"	60	35.06	35.25	85	.87			
" "	"	"	7.31	"	60	35.88	32.75	1.18	.92	5.50 lb.=16.18 %	43=42.36 %	.04½= 5.03 %
July, "	"	Double.	14.62	"	40	35.68	37.70	91	1.16			
" "	"	Single.	7.21	"	40	35.68	30.10	1.41	1.35			
" "	"	"	7.31	"	40	35.22	31.30	1.57	1.26	6.95 lb.=22.64 %	58=38.93 %	.14½=11.11 %
May, "	"	Double.	14.22	Warp.	68	33.43	44.00	52	.84			
" "	"	Single.	7.11	"	68	33.52	41.25	55	1.12			
" "	"	"	7.11	"	68	32.64	42.66	60	1.23	2.40 lb.= 4.87 %	5½= 9.57 %	.33½=28.51 %
April, 1882,	"	Double.	14.22	"	20	33.25	47.50	not	.88			
" "	"	Single.	7.11	"	20	33.25	44.95	kept.	1.22	2.55 lb.= 5.67 %		.34 =27.87 %
Aug., "	10 "	Double.	7.11	"	112	33.84	51.92	12	.96			
" "	5 "	"	14.22	"	112	34.07	47.53	32	1.06	4.39 lb.= 9.24 %	20=62.50 %	.10 = 9.43 %
" "	10 "	"	7.31	Filling.	144	35.52	45.72	40	.92			
" "	5 "	"	14.62	"	76	35.26	42.46	78	1.11	3.26 lb.= 7.68 %	38=48.72 %	.19 =17.10 %

Whiting frames, Sawyer spindles, Draper double rings. Front roll, 84 revolutions, warp. Front roll, 100 revolutions, filling. Twist 27½ warp. Twist 21.14 filling.

SUMMARY OF TESTS AT GLOBE MILL.

Double Roving Gains.	Filling.			Warp.		
	Strength.	Ends Down.	Variation.	Strength.	Ends Down.	Variation.
With double draft,	19.41 %	40.64 %	8.07 %	5.27 %	7.57 %	28.19 %
" single draft,	28.39 %	69.48 %	24.25 %	15.18 %	66.09 %	35.18 %
Difference . .	8.98 %	28.84 %	16.18 %	9.91 %	56.52 %	6.99 %

		Single Roving.	Double Roving.
Comparative strength of Warp and Filling.	Warp . .	42.95 lbs.	51.92 lbs.
	Filling . .	32.38 "	45.72 "
		10.57 lbs.	6.20 lbs.

SUMMARY OF TESTS AT PACIFIC MILLS, LAWRENCE.

	Davis and Furber frames. Fanal spindle. Short boss rolls.				Draper double rings (new) Double carding — Texas cotton. Draft, 6.93.			
	Roving — Single.				Roving — Double.			
Hank Roving .	4.37		4.40		8.84		8.80	
Speed . . .	76.		99.		76.		99.	
Number of tests,	104.		104.		104.		104.	
	Hicks H. C.		Hicks H. C.		Hicks H. C.		Hicks H. C.	
Travelers . .	1-0		5-0.		1-0.		5-0.	
Twist . . .	25.48		25.48		25.48.		25.48	
Yarn.	No.	Lb.	No.	Lb.	No.	Lb.	No.	Lb.
Average . .	28.49	51.52	29.85	52.02	29.25	63.19	29.35	62.28
Strongest . .	28.17	62.00	29.41	62.00	26.66	70.00	28.17	71.00
Weakest . .	28.57	44.00	29.85	43.00	30.30	53.00	28.98	53.00
Finest . . .	30.77	51.00	31.84	54.00	31.25	60.00	30.86	60.00
Coarsest . .	25.97	62.00	28.01	54.00	26.66	70.00	27.02	68.00
Above average lb.	43 threads.		51		49		53	
Below average lb.	47 threads.		48		55		51	
Total average,	29.17		51.77 lb.		29.30		62.73 lb.	

SUMMARY OF TESTS AT PACIFIC MILLS, LAWRENCE — *Con'd.*

	Davis and Furber frames. Pearl spindle. Short boss rolls.		Draper double rings (new). Double card — Texas cotton. Draft 14.98.			
	ROVING — DOUBLE.					
Hank Roving	4		4		4	
Speed	78		99		102	
Number tests	16		16		16	
Travelers						
Twist	25.48		25.48		24.52	
YARN.	No.	Lb.	No.	Lb.	No.	Lb.
Average	28.69	57.87	28.35	58.06	29.09	55.63
Strongest	27.54	65.00	27.77	65.00	28.73	64.00
Weakest	29.41	52.00	28.57	51.00	30.03	49.00
Finest	29.85	52.00	29.41	52.00	30.77	52.00
Coarsest	27.54	65.00	27.02	64.00	28.17	60.00
Above average lb.	9		9		9	
Below average lb.	7		7		7	
Total average	28.71		57.19 lb.			

62.73 — 51.77 = 10.96 ÷ 51.77 = 21.17 % stronger. 57.19 — 51.77 = 5.42 ÷ 51.77 = 10.47 % stronger.

The PRESIDENT. At our last meeting, when this subject was referred to this meeting, a suggestion was made that parties who were sufficiently interested in the matter should make experiments. Possibly some may have made such experiments. We should be very glad to hear from any one on the subject.

Mr. DRAPER. It seems to me that the series of experiments which we have just had, which, I have no doubt, were very carefully made, present matter of very great interest to our manufacturers. While I did not know that the experiments were being tried, they come exactly in line with what I suggested theoretically in regard to this matter as far as we had got. I said that we agreed on two things; that double roving was better, with a fair draft, than single roving, but it cost more to make it. I also said that there was no doubt that excessive draft is injurious; probably I said, whether in double or single roving, but certainly in single; and the real question was whether, in doubling your roving and submitting it to this

double draft, you did more harm by your excessive draft than you did good by doubling your roving; and these experiments come in here and demonstrate the fact, that you do much less injury to the strength of the yarn by your excessive draft than you gain by the double roving. Consequently, from roving which costs you just the same to make, you can make yarn cheaper, especially filling, by subjecting it to a double draft. But the other question comes in here; that is to say, how fine roving you can afford to make.

The PRESIDENT. I believe Mr. Lockwood did not have an opportunity to be heard at our last meeting on this question.

Mr. LOCKWOOD. I think the subject was pretty thoroughly discussed then, and with what has been submitted to-day, it seems to me there need not be much more said. I will simply say, that I read the discussion, as published six months ago, with a good deal of interest, and perhaps I was more interested from the fact that I had been, I will not say experimenting exactly, to any very great extent, but I had adopted to a considerable extent the system of spinning roving double. I do not quite like the terms that Mr. Lippitt uses—"double draft," and "single draft." I should say "double roving with heavy or medium draft," and "single roving with light draft," rather than "double roving with double draft" and "single roving and single draft."

I will only say, without going into any criticisms upon what others have said here, or upon what others said at the previous meeting (though there were some things said that did not accord with my own views), that the result of our operations were so far favorable as to induce us in the construction and starting of our No. 2 mill at Waterville, to use double roving except on the mules; all the warp and a portion of the filling is spun on frames. I did not believe then, I do not believe now, that it is wise to draw fourteen on double roving. I compromised by adopting a draft of about twelve, intending to go under rather than over. Not that I supposed that a draft of twelve would be any thing near as good as a draft of ten or less; that we could make better yarn with a draft of ten, or less than a draft of twelve, I had not the slightest doubt; it was only a question where economy might come in. Of course, you might draw seven or six, and gain in the perfection of the yarn, but the extra cost would be so great that it would

not be a matter of economy to run down to that excessively low draft; we must, therefore, compromise. Were I to build a mill to-day for No. 30 and upwards, I should organize to spin my warp double, at a draft of about ten. That would of course cost a little more in making the roving, but I should gain in the spinning, I should gain in the evenness of the thread, and I should expect to gain in the weaving. Where the exact point is, as I have said, I do not know. That fourteen is too high I have not any doubt; that six is too low I have not any doubt, in an economical point of view. If I started with the view of making the most perfect thread possible, I would double and have my draft pretty low, provided, in getting that low draft with double roving, I was not forced by circumstances beyond my control for the time to have excessive draft at some other point.

Now, I can see very clearly that gentlemen may go on experimenting on this question of double roving and light or heavy draft, and come to very different results, and come to very erroneous conclusions. Why? Why, to have the roving double, with a light draft, they are forced, in some cases, to draw excessively at some point before the roving reaches the spinning-frame. Well, that would be as fatal, perhaps more so, than a heavy draft in the spinning. Now, if you want to test the true merits of this question of double roving and high and low draft, you want to have your organization, from the very beginning, commencing at the railway head, adapted to the hank-roving you desire to produce. If you want to produce ten-hank roving instead of five-hank, you want to start very differently from the railway head and the process immediately following the head; and when you reach your roving-frames, particularly, you must have a weight of sliver that will enable you to get the necessary amount of doubling to work the sliver down to the right weight, and do it in a way not to injure the evenness of the work or its perfection. But assuming that you start right to carry your cotton through in a scientific way from that point until it comes to the spinning, there is no sort of doubt that you will get stronger yarn with the double roving in the spinning than you will with single; and you will get better work with light draft in the spinning than you will with heavy draft in the spinning. The only question to be determined is, where the economical point comes in.

Of course, if you draw six or seven instead of fourteen, you need twice the length of roving, and you not only need twice the length of roving, but each roving-frame will make less hanks of roving per day; so that you need more than twice the number of roving-frames, because you have got to get twice the length, and you cannot produce the same length per spindle.

There are quite a number of elements which enter into this question, and in reaching the exact and correct conclusion in regard to this matter of double spinning, all those elements must be considered. That the principle is right, that there is an element of value there, I have not the slightest doubt.

Mr. Atkinson. As long ago as the time of David Whitman the subject of double roving was brought before some of the Lewiston corporations. Some French cottons were sent to him which he found of the very best quality, and their superior quality was attributed to double roving and light draft. At that time, the market not being as critical as it is now, and people not being willing to spend their money as they are now for the very best thing that could be made, no attempt was made to enter into the manufacture of these goods. As I remember them, they were not fine goods: they were French medium cottons, of which a very few could be sold by such houses as C. F. Hovey & Co. for double the price of American goods of the same kind. There the secret was in doubling on the spinning, and the matter was thrown aside on the ground that the market was not sufficient to warrant the expenditure for the machinery which would be required.

Mr. Lockwood. Perhaps I ought to say, inasmuch as I have commenced talking on this subject at all, that the question of double roving as applied to mules or spinning-frames is a different thing, and especially for warp. The question may be asked, If double roving is better for a ring-frame or throstle-frame for making warp, why is it not better if you make your warp on mules? Well, in some respects it would be better. I once knew a mill, and I think the agent of that mill is here now (a man who used to be connected with it I see is here, if the agent is not), — which was organized for making No. 30 mule-warp, and No. 36 mule-filling. The warp was spun with double roving and the mill was successful, but there were some difficulties. Subsequently, that mill was changed, perhaps not, however, until they changed from mules to ring-frames; so that

the change, and the result of the change, would not exactly illustrate the point under consideration. But the difficulty in spinning warp double on mules is this: sometimes the roving will run out, or break back; on the spinning-frame, invariably, the end breaks when it is only half size, and so almost invariably, if it is mule-filling, on account of the twist. But in spinning mule-warp with double roving, twisted as the warp is usually twisted, if one roving breaks or runs out, there will be twist enough for the other to hold together, and, before it is discovered, you will have one, two, or three stretches, as the case may be, of single yarn. The boy goes back and pieces it up, and the work goes on; and when it comes to spooling the warp, it may go through; but when it gets into the weaving, there are a few fine threads, and they will be constantly breaking. I do not say that double roving is not the best, — I will not go as far as that, — but I do say that there are some practical disadvantages in the use of it, hard to be overcome; and, all things considered, I have my doubts whether there will not be more disadvantage from imperfect or single roving going through without being discovered than the advantage you will get from double roving. But that does not apply to the ring-frame.

The PRESIDENT. I would like to ask Mr. Draper exactly where he would begin with double roving and double draft, — at what number?

Mr. DRAPER. Mr. President, I have not followed this matter up under different circumstances sufficiently to make what I consider a definite answer to that question. My investigations were confined, in the first place, mainly to the matter of spinning 28 warp and 36 filling, with the ordinary preparation. The question which was presented to me at first was this: take this roving that has been prepared, — No. 28 warp and No. 36 filling more particularly, and have at the time four-hank roving, if you please, — this roving being made, what is the best way to spin it? How can you make it into yarn the cheapest? and when you have got it done, which yarn will be the best? That, of course, opens the whole question as to its effect in other respects, and whether you had better change the two more or less. I became satisfied, and so asserted, that you could take, we will say, four-hank roving, prepared to make average good filling, and spin it double on the frames very

much cheaper, because it would run better than you could single roving, and when you got it done it made stronger filling with the same twist. That was as far as I had got in the matter. And now the question which Mr. Lockwood brings up as to economy, of course is a very important one. You will see that for making print goods, it would be folly to say, "We will go to work and get in all the necessary roving machinery and every thing that will bring it down to half the size for ordinary print-cloth;" because, when you have got your cloth done, it will be very much better, and with that very thin cloth what you can save in weaving won't amount to much perhaps. Therefore I have made up my mind, and I think it is as fully proved by the experiments that other gentlemen have made as any thing can be, that this is the correct position to take in regard to that with respect to print-cloths. Now Mr. Lockwood, in his experiments in doubling the roving, with a draft of twelve instead of fourteen or sixteen, as it would be in the other case, is producing a different class of goods, to a certain extent, to wit, sheetings; and when you come to weaving sheetings, where you are weaving your texture very close, and beating in the filling, you are liable to break yarn such as you might use for print-cloths. Therefore it brings in, as almost every thing else does, the use of your judgment and experience whenever you change the conditions. Now, taking a pound of No. 36 filling, and weaving it into print-cloth, I believe there is no question about the fact that you had better put in the ordinary roving double and draw it double than use it single. If you are going to make a quality of goods like the Amory goods, where you want very strong yarn, I would not put in double draft, I would put in double roving. I am coming to the conclusion that you cannot afford to do without double roving scarcely anywhere, and I think that is the conclusion that we shall all be driven to sooner or later.

Mr. Lockwood. Lest I might be misunderstood in regard to the effect of double draft, I will say that, on about six thousand ring-spindles that we have at our mill in Waterville, making filling, we started with single roving, with the exception of perhaps one or two of the first frames; but we are now running them all double roving but one or two frames. I do not know that there is more than one; and as we were drawing about eight with the single roving, — drawing more than on

the warp, because the numbers were finer, — the agent started up two frames drawing sixteen, or sixteen and a fraction, and found that he had better work, and the frame ran better, with less breakages, with the sixteen draft and double roving, than with the eight draft and single roving. But not being a believer in an excessively high draft, I immediately requested him not to run so high draft, but to make his roving finer, and cut down his draft.

The PRESIDENT. Is there any thing more to be said upon this subject before we leave it? If there is not any thing more, we will consider the discussion closed.

There was one Committee appointed a year ago, from which we have not heard. Mr. Pray was appointed a Committee to investigate an invention for card-setting, offered by Mr. William B. Earle. We should be glad to hear a report, if he has any to make.

Mr. PRAY. Mr. President, I was away in the South at the time I was appointed as this Committee, and when I was informed by the Secretary of the matter, I took immediate steps to correspond with Mr. Earle. I could not see the gentleman until some time in December. He finally called at my office. He is perfectly blind, and very old; and, after a long talk with him, the utmost I could obtain from him was the sight of a couple of tin cams, and a very long talk upon the advantages of his invention, and what it would do. I could not get either head or tail of what the machine was, or what it was for, beyond the fact that it was a very radical improvement in putting the wire into the clothing that we were using, or into the leather to make clothing; and the matter was left until just previous to the April meeting. About two weeks before the April meeting, I wrote Mr. Earle again, that I should be very glad indeed to see him, and offered, if necessary, to pay his expenses. He came down to the office a second and third time, and all that I could learn then and there was, that the machine had gone into the hands of some persons, either relatives or friends of his in the city of Worcester, and was there to be perfected; and that he had not any thing more to say. His first idea was to obtain some assistance from manufacturers in building the machine. That is the result of it. The amount of information that I am able to give about the invention is very little, — nothing, in fact. I have not been able to find

out what the machine is, or what its general features are; so that the report amounts simply to nothing.

On motion, the report of the Committee was accepted.

Mr. PRAY. There is a matter which I would like to bring before the New England Cotton Manufacturers' Association. I have taken no part in any discussion here for the last three years, with the exception of asking a simple question now and then. I have been investigating cotton fibre, and looking about among the cotton-mills, cotton-spinners, cotton-plantations and ginneries, for the last four years, entirely at my own expense, with no encouragement whatever from this Association, with the exception of some six or seven members. I am going to say that, to a certain extent, I am handicapped by the prejudice which exists, and yet I propose to explain the matter here and now.

You have heard a great deal of argument here, and I am the recipient of a great many letters every week, in my editorial capacity, asking the reason and the cause of the existing state of things. You have heard the tare of cotton discussed, the waste, and all these etceteras. I am now going to offer a suggestion to the New England Cotton Manufacturers' Association, and to each and every individual member. We are just commencing to use a crop of cotton, which, as I predicted in July, will be the worst crop of cotton that has ever been spun in New England. My investigations in the sections of country where cotton is raised, where I have spent thirteen or fourteen days, and travelled hundreds of miles, visiting a great many ginneries and bringing home samples for microscopic and photographic work, have satisfied me that you have not begun yet to realize the difficulties which you will experience later in the season. You have secured the ripe cotton from the field; it has come on in splendid order; as my friend Atkinson remarked to-day, it is elegant-looking, but it will be any thing but elegant in the working. The second picking, which is now taking place, after the rains, will be more or less smeared with sand and dirt. The third picking, which is to follow, will not only be bronzed and blue and rusty, but will be rough and uncouth. The cotton which is now in the market, and is in transit, is the best you will get this year. I have visited not less than thirty-four ginneries since the fourth day of October; some of them in the woods, some of them by the railroads, some private and some

public. I find that the sixty-saw gin, that is intended to do five bales in a day, is doing nine to thirteen bales in from twelve to sixteen hours; and the duller the saws, — it being a well-known fact among cotton-ginners that that kind of saw makes the best-appearing sample — I say, the duller the saws, the harder the cotton roll; and if some of you do not get sick of cotton before the first of next May, I shall be very much mistaken.

Now, the proposition has been made here over and over again that something be done. I am free to confess that I have an axe to grind. I am the agent for a gin which has just been completed, which will gin five or six bales a day, positively carrying the fibre from the seed of the cotton always in a continuous direction. We want that gin examined by the smart men you have amongst you, and I propose to this Association, if there is anybody here who has interest enough in it, that any motion which you choose shall be made to have a committee appointed, by the Chair, if you like, of not less than three, and as many more as you please, at any time within the next four or six weeks, whenever it can be made mutually agreeable, at a time to be set which will accommodate you best, to go with me and make a practical test of that gin, both upon upland and Sea-Island cotton, and make a report to this Association, without any reference to me. The company of which I am agent does not want to issue any licenses; they have no stock to get rid of, but they have the matter completed. The gin in question is a roller-gin. Some of you who were at Atlanta know the great trouble that has existed from the fact that you can only gin a very small quantity on the roll-gin without seriously injuring the fibre. That difficulty we claim to avoid to such a degree that no possible injury is done to the staple.

The gin is not yet put upon the market. The third one, and the first and only complete one, is just finished. It is entirely at your service any day after about two weeks — I cannot set any time before that — when I shall be very glad to have any committee that may be appointed here go with me. I have some two or three tons of cotton that can be used for the test. I want you to run it yourselves, I want you to examine it carefully and find all the fault you can with it, and if there is anything good about it, all I ask is, that you will report to the Association. We propose to have the gin in the field next year, and show that the cotton which is sent to you need not be all cut to pieces in the gin.

Referring to the improvements that Mr. Atkinson has remarked upon, I will say that I have seen four or five of the new gins. In one or two cases, they have two saws working against each other. The idea is to gin twenty bales of cotton with an 80-saw gin in ten hours. I have examined the product of one of those gins under the microscope, and you might just as well have taken that cotton and put it between two grindstones as to put it between those two saws.

There has been another improvement, so called. I called it "The Cotton-Spinners' Devil" the first time I saw it. That has a rapidly revolving steel brush running against the motion of the saws. As Mr. Atkinson remarked (he might have used a very much stronger term) the cotton is completely cut up, or more properly, chewed up, into nothing more nor less than the poorest kind of cotton waste. In some six hundred fibres which were counted, after being carefully drawn out on the glass slide, there were less than fifty of the ordinary length of cotton fibre. This is one of the *improvements* which have been introduced in the ginning of cotton.

Right here I want to say one word more, and I am done. The cotton-factors in the South want to know what the spinners of the North want. The cotton-planters, or a great many of them, those especially who are in the vicinity of Atlanta, are not only willing but anxious to adopt any thing that will give us more and better cotton. They are in a better position than ever before to buy machinery, and we want to give them something that will enable them to give us better cotton. What we are after is to give this thing a thorough commercial trial. We do not ask you to advertise it or to indorse it, except for the use of this Association. If such a committee is appointed, I pledge you that I will not ask you for any certificate, any recommendation in any way, or any signature, but simply that your report be made at the next meeting of the Association that you have examined it. We believe we have something that has merit in it, and we know it is free from very much of the annoyance and loss, and the absolute out-and-out injury that is being done to the staple, and never more than in the 1883 crop. There are too many of these new gins and new improvements. Very many planters are trying to raise more cotton, and the ginners, or, as I term them, the "cotton-butchers," are most effectually doing their work. They have reduced the price of ginning

from thirty to fifty per cent, and they are trying to make up for the loss in that direction by doing an extra amount of work on their gins.

Mr. Draper. I was somewhat surprised to hear that this Association had appointed a committee to examine an invention, or something of that kind, concerning the manufacture of cards, and although it did not amount to much, it seems to me that this is a departure that we want to avoid. I do not believe that this Association wants to furnish committees, when called upon, to examine cotton machinery, or woollen machinery, or any thing of that sort, and make a report or any thing of the kind to the Association. I am satisfied it will open the door for something that we shall be sorry for. I am quite willing, and would be glad, if anybody has any thing appertaining to the cotton manufacture, or any improvement, that they should come before this body and let us know all they know about it; but when it comes to the appointment of committees, if there are any axes to grind, which the gentlemen speaks about, they will be very sure to be ground, unless they are different from ordinary individuals; and, for one, I hope that this Association will not appoint any committee, or do anything in that direction, except it be recommended by the Board of Government.

Mr. Pray. With great respect for my friend Draper, I have already stated that I do not crave this examination for any other reason than that I know there are men here who are deeply interested in this subject. I do not ask your indorsement, I do not want any certificate, but if this Association desires to appoint a number of their members to go and witness a trial of that gin, for their own information and benefit, I shall be glad to have them do so. I have before said that I control the corporation, and I assure you that I will not ask you for any certificate, for any recommendation, for any guaranty, or any thing else. If the members of this Association want to sit down and shut themselves away from information, I have nothing more to say, I do not ask you to indorse it in black or white, or verbally. The thing is not for sale. We propose to give you better cotton. You have argued this question here *pro* and *con.*; you have argued this, that and the other patented arrangement, and I believe that, as a member of this Association (I do not know that I have ever done it any harm), I have a right to lay this before you as much as my friend Draper has

this, that, or the other matter. I simply ask the Association to appoint this committee, if they choose to do it. I do not care whether it is done through the President, the Board of Government, or any other part of your Association. I don't care what you do with it. I offer this Association the opportunity, at some time within a month, to go and make a trial of a new cotton gin. I do not ask you to subscribe to it; I do not want to sell any stock; I haven't any patent to peddle; it is simply a matter of information; you may do just what you like, and I do not care whether you make any report or not.

Mr. JOHNSTON. I think it is perfectly consistent with the objects of this Association to investigate anything that we think is going to be for the advantage of the cotton manufacturer; nor do I think there is anything more important — it goes down to the very foundation of our success — than the way cotton is handled in the gin; and I think if any gentleman who is a member of this Association comes before us and states that there is a machine, or a contrivance, or an invention of any sort whatever, that, upon consideration, this Association may deem to be of advantage to the cotton manufacturers, it would be perfectly consistent, as I say, with the objects of the Association to appoint a committee to investigate it. I would suggest, as there is nothing more important than cotton-ginning, that a committee be appointed to look into this matter and report at the next meeting.

Mr. ATKINSON. I have been familiar with the progress of this gin for many years. I have seen it tried twice and fail for want of proper care in its construction. I have seen it at last pass into proper and right hands. I have very great confidence in it, and I do not think this Association can do a wiser or better thing than to appoint a competent committee to study it and pass upon its merits. I agree most fully with Mr. Johnston. I can speak now all the more freely because I have absolutely no direct interest in any of the questions involved.

Mr. DRAPER. I think that the members of this Association cannot help seeing, at any rate, that this is an entirely new departure. There never has been, to my knowledge, any committee asked for to look at any improvement outside. There certainly never has been any asked by me, or any suggested by me, and I am fully of the opinion, whatever you may do (of course that is a matter for you and not for me, I only say what

I believe), that you are entering upon a road which you will finally be sorry that you ever entered upon. You will want more than four hundred committees within four years. If you have to examine the number of things that are brought to me individually, you will need to appoint all the members of this Association on committees to look at the different things that are supposed to have merit in them. I fully believe that you will be sorry for this departure, if you make it. It is evident enough that this is, in some way, expected to be of advantage to this invention. The man would not have said anything about an axe to grind unless he had one, and in some way this Association, through its committee, is to be committed, or supposed to be committed, to recommending that thing. It seems to me that the cotton-planters are the people to judge, in a measure, about that; but whether it is a spinning-frame, or a mule, or any improvement that we want, I don't believe we want any committee. I believe it should be a committee of the whole, and that all should have the advantage of hearing what there is said about it, and what inducements are offered to manufacturers to get it. Now, for instance, supposing you take up any of these spindles that have come up; suppose you go back and appoint a committee to examine the Sawyer spindle, or the Garsed spindle, or suppose you had committees to examine a dozen other spindles, and one committee recommends one, and another committee recommends another, how much wiser would you be? The fact is, I believe these things should stand on their own merits, as far as this Association is concerned. I never have asked any indorsement from this Association of any thing that I had; I have only applied to the individual members, and brought such evidence as I was able to of its value to them. I am willing to trust it on that ground, and want to, in future.

The PRESIDENT. I would remind the Association that they are opening no new door in the event of the appointment of this committee. Article 4th of the By-laws contains the following: —

"The Board may, from time to time, as they shall deem expedient, appoint committees from among their own Board, or from the members at large, to collect statistical information, examine new inventions or processes in manufacturing goods, as also to prepare essays on subjects of interest to the Association."

Mr. DRAPER. It is only a question of practice. I do not question the right of the Association to do this, at all. I did not know of the appointment of any such committee as the one whose report we have just heard, until the report was made by Mr. Pray.

Mr. GARSED. My recollection goes back for some time upon this matter of the usage of the Association in regard to the examination and discussion of the merits of different inventions. The gentleman has referred to the spindle question. I remember that for many years we discussed spindles and pickers, until the matter became unpleasant to the Association, and caused the closing of doors that had been previously opened.

Now, as to this cotton-gin. Some gentlemen who happened to be at Atlanta, spent a great deal of time in looking up cotton-gins of the different kinds, and they made up their minds it was the most miserable business they ever undertook. To illustrate what the average cotton-planters know about ginning, I will mention this fact. One morning, when I was in that building, a planter came along with a bunch of cotton in his hand, and a bundle under his arm, of which I did not know the contents. It turned out to be Ozier silk cotton. Mr. George Barrows, of Willimantic, was standing alongside of me, and we examined this cotton. It was probably the worst cut up lot of cotton I have ever seen, from the best material I have ever seen. We asked him to put it through a little roller-gin there was there. He did so, and Mr. Barrows bought it for sixteen cents a pound. The gentleman would have sold it for ten cents a pound, and thought he had made a good bargain. There is an illustration of the difference between ginning properly and not ginning properly.

Now here comes an invention which it is claimed will not tear the cotton, will not destroy the fibre. We all know cotton ginned by the old McCarthy gin was considered better cotton, and commanded a better price, than any cotton ginned by the saw-gin. Now we have the assertion of a gentleman that he has a better gin than has ever been invented before, and we are simply asked to appoint a committee to examine it, and make a report. It seems to me a most reasonable proposition. What harm can possibly come from it? We are not asked to buy it, to indorse it, or to subscribe any money for it. The gentleman simply asks for the appointment of a committee

to go and examine it. What more reasonable thing can be asked than we should go and see it, and judge for ourselves? I cannot see why my venerable friend Draper, after what has passed in this room, should object to it.

The question was then put on the motion for the appointment of a committee, and it was adopted.

Mr. SMITH. I would like to ask the Committee, if it is practicable, after they have examined that gin, to have the machine brought here, where it can be inspected by the Association as a whole. I do not know whether it is of such size that it could be exhibited or not.

Mr. PRAY. The machine which we have now built weighs something like twenty-two hundred pounds. You will understand that I have taken hold of this thing at a very late day, and completely re-organized it; and now that we have a machine which we consider a success, we propose, after your examination, to take the machine down, and have new drawings made, and build the frame so that it can be taken apart and shipped. It is now in process of construction; it cannot be shipped before January or February; but now that you have decided to appoint a committee, if I am alive in April, I will try to have the gin in Boston, with one or two tons of cotton, so that you can examine it.

We do not care to exhibit the machine to two or three hundred persons, under existing circumstances, but, as I tell you, I control the thing through parties who have put their money into it (and they have put thirty thousand dollars into it in two years), and any pledge I make to you shall be sacredly kept. I will show you the machine, and let you have an opportunity to try it on Sea-Island cotton, on upland, and on the worst trash you can pick up. I want you to see the machine with your own eyes, and make your own tests. Then, if you want the machine brought here, I will endeavor to have it somewhere in the city of Boston. I shall have to look around for a suitable place, because we shall have to use power.

Mr. ATKINSON. I think that there can be no doubt that the power can be furnished in the new Mechanics' Art Shops of the Institute, whenever Mr. Pray is ready to set the machine up there.

Mr. PRAY. Very well; then if your Committee shall report, or among themselves shall so desire, I will endeavor to

have the machine in the Art Shops of the Institute of Technology next April, so that everybody can see it, and so that you can judge of its action by your own eyes. When I said that I had an axe to grind, I said it because I did not propose to come before you in any surreptitious way. I have never done it. In saying that, I did not intend to cast any reflection upon anybody else. I proposed to tell you that I was interested in this machine, and some of you know that I have been working on this subject for the last three years. I have hesitated about it some time, as you see by the clock. I have made the offer without any wish to infract or infringe any rule of this Association. I do not wish to make a personal issue with my friend Draper or anybody else. I have asked you as an intelligent and enterprising set of men, whom I have known for twenty odd years, to go and examine the machine and form your judgment; and I tell you frankly, I do not want any indorsement, or recognition, or certificate, or any thing else; and if I live until April, I will agree that every thing you say in regard to the gin shall be expunged from the record, if you desire it. I do not ask for any advertisement, I do not want any indorsement, but if we have a gin that will give you better cotton, it may be for your interest to know that you can get better cotton if you want it.

The President announced the Committee as follows: Messrs. D. W. Johnson, of Claremont, N.H.; W. F. Goulding, of Lewiston, Maine; Richard Garsed, of Philadelphia, Pa.; J. W. Wattles, of Canton, Mass.; E. S. Davis, of Lewiston, Maine.

Mr. Draper. Do I understand the gentleman correctly as saying that he does not want any report from this Committee? I think he has said so several times. In that view of it, I hardly know what position he is going to place the Committee in. If it is simply to have a committee to go and look at the gin without making any report, we might understand it so. I want to call your attention to this fact, that if they make a report in favor of any one thing, it will be the first report of the kind that has been made by any committee or by the Association itself. This Association, as far as I remember, has never voted that one thing was better than another. Now, if they are going to take up that line, if they are going to undertake to decide upon different things that are brought up here, and to give their indorsement through a committee or through the

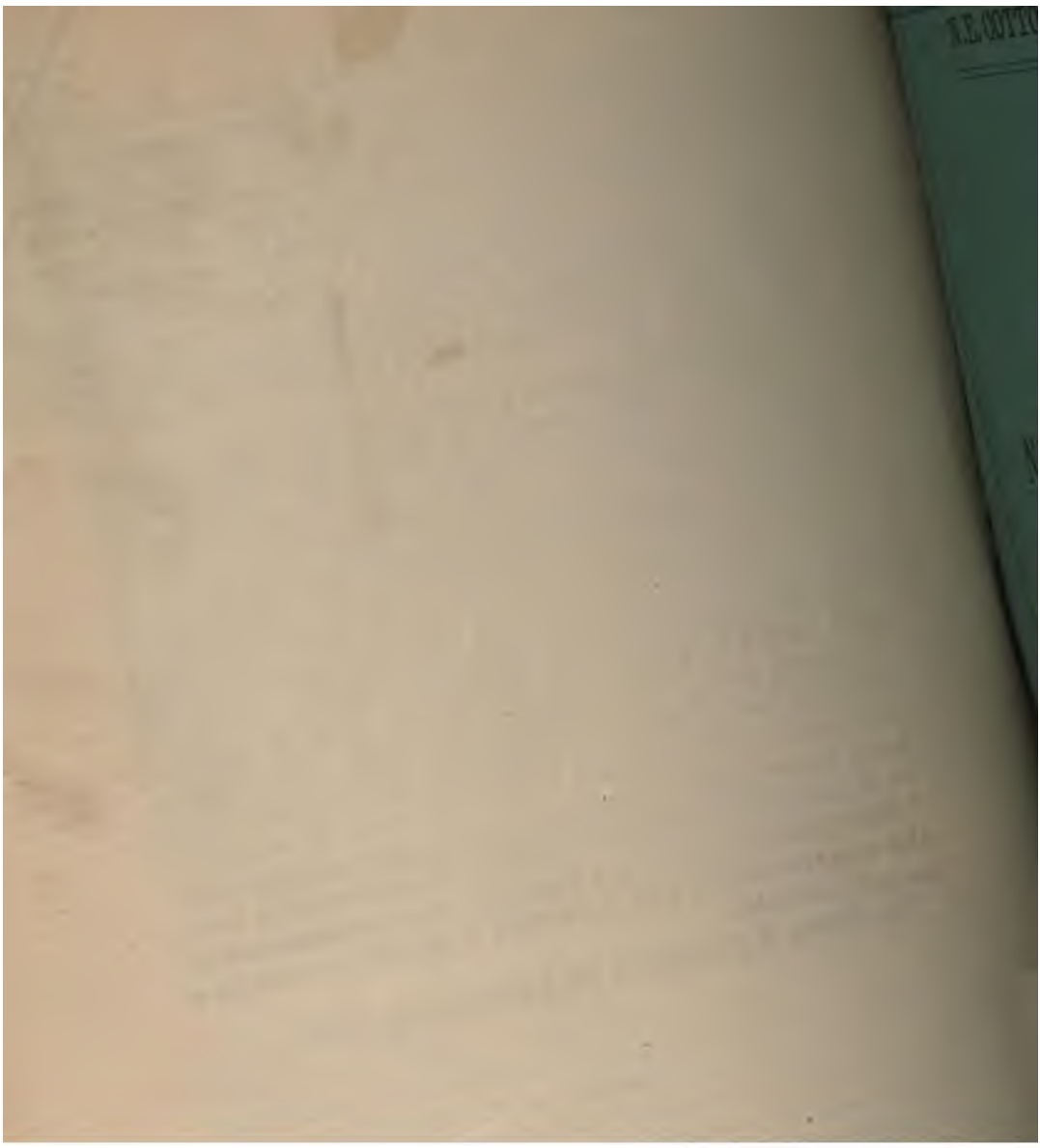
whole body, and say, "We vote that the flyer spindle is better than the ring spindle," or "we vote that this particular flyer spindle is better than any other spindle," or "we vote that mules are better than frames," we have the questions up and discuss them, and then "you pay your money and you can take your choice." But I tell you that this is a new departure which will bring you into trouble. I hope you will consider it.

Mr. ATKINSON. Mr. Pray has some very extraordinary photographs of cotton fibre, which I hope he will show, now that there is light for the members to see them. He is a little modest about it.

The Secretary read an invitation from the National Cotton-Planters' Association, inviting the members of the New-England Cotton Manufacturers' Association to attend and participate in the proceedings of the meeting of the Planters' Association, to be held at Vicksburg, Mississippi, commencing Nov. 21.

Mr. LOCKWOOD. If there is a moment left, I would like to make one additional remark, as it did not occur to me when I was up before, and it has some little importance as bearing upon the question under discussion this afternoon. Gentlemen may be led to make further experiments upon the question of double roving, and I suggest this: That, if the frame is weighted just right for the single draft, and you add double the amount of cotton and double the draft, there is more labor thrown upon the rollers, and hence the weighting should be adjusted to the amount of labor to be performed by them. I throw that out merely as a suggestion, that gentlemen making the experiment may take it for what it is worth, in reaching a proper conclusion.

On motion of Mr. Garsed, the Association adjourned.



[No. 36.]

N.E. COTTON MANUFACTURERS' ASSOCIATION.

PROCEEDINGS

OF THE

NINETEENTH ANNUAL MEETING,

HELD AT BOSTON, APRIL 30, 1884.

PRECEDED BY

CATALOGUE OF MEMBERS.

BOSTON:
FRANKLIN PRESS: RAND, AVERY, & COMPANY,
117 FRANKLIN STREET.
1884.

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Office of the Association, Room 68, Sears Building, Boston.

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John A. Collins . .	Perry Manuf. Co.	Newport, R.I.
D. E. Converse . .	. . . . .	Glendale, S C.
A. G. Cumnock . .	Boott Cotton Mills	Lowell, Mass.
James W. Cumnock .	Dwight Manuf. Co.	Chicopee, Mass.
John Cumnock . .	Great Falls Manuf. Co. . . .	Great Falls, N.H.
A. Dahlgren . . .	National Manuf. Co. . . .	Nashville, Tenn.
A. W. Danforth . .	Shanghai Cotton Cloth Mill Co.	Shanghai, China.
John W. Danielson .	Quinebaug Co.	Providence, R.I.
E. S. Davis . . .	Continental Mills	Lewiston, Me.
B. D. Davol . . .	Pocasset Manuf. Co. . . .	Fall River, Mass.
James Dempsey . .	Lewiston Bleachery	Lewiston, Me.
Frederic Dexter . .	. . . . .	Boston, Mass.
George Dexter . .	Pepperell & Laconia Cos. . .	Boston, Mass.
George Draper . .	. . . . .	Hopedale, Mass.
William F. Draper. .	. . . . .	Hopedale, Mass.
Joseph Dronsfield .	Fletcher Manuf. Co.	Providence, R. I.
David H. Dyer . .	Quequechan Mills	Fall River, Mass.
William A. Eastman,	Ocean Mills	Newburyport, Mass.
Charles L. Eaton . .	. . . . .	Providence, R.I.
Isaac Eaton . . .	. . . . .	Nashua, N.H.
Herbert R. Farnum .	Bernon Manuf. Co.	Georgiaville, R.I.
Herbert Fisher . .	Anniston Manuf. Co. . . .	Anniston, Ala.
M. F. Foster . . .	Langley Manuf. Co.	Langley, S.C.

Philip H. Fowler . .	Gloucester Gingham Mills . .	Gloucester, N.J.
J. Dwight Francis .	Pontoosuc Manuf. Co. . . .	Pittsfield, Mass.
Frank H. Fries . .	. . . . .	Salem, N.C.
Melville Gambrill .	Arlington Mills Manuf. Co. .	Wilmington, Del.
William B. Gambrill,	Druid Mills	Baltimore, Md.
A. J. Gardiner . .	Danielsonville Cotton Co. . .	Danielsonville, Ct.
James G. Garland .	. . . . .	Biddeford, Me.
Richard Garsed . .	Wingohocking Mills	Philadelphia, Penn.
James A. Gary . .	Alberton Cotton Mills . . .	Baltimore, Md.
Charles J. Goodwin .	Indian Orchard Mills . . .	Indian Orchard, Ms.
Alfred M. Goodale .	Boston Manuf. Co.	Waltham, Mass.
W. F. Goulding . .	Androscoggin Mills	Lewiston, Me.
David Gowdey . .	. . . . .	Providence, R I.
Arch. M. Graham .	Gloucester Manuf. Co. . . .	Gloucester City, N.J.
James Grant . . .	137 Duane Street	New York City.
Benjamin Greene . .	Cabot Manuf. Co.	Brunswick, Me.
Frederick Grinnell .	. . . . .	Providence, R.I.
Z. D. Hall	. . . . .	Lowell, Mass.
H. P. Hammett . .	Piedmont Manuf. Co. . . .	Greenville, S.C.
J. F. Hanson . . .	Bibb Manuf. Co.	Macon, Ga.
C. M. Harris, jun. .	. . . . .	Oakdale, Mass.
Frank Haskell . .	Westbrook Manuf. Co. . . .	Saccarappa, Me.
Thomas Haskell . .	. . . . .	W. Peterboro', N.H.
William Hayes . .	Barker Mill	Auburn, Me.
Jefferson Higgins .	. . . . .	Dodgeville, Mass.
John H. Higgins . .	Forestdale Manuf. Co. . . .	Slatersville, R.I.
Charles L. Hildreth .	. . . . .	Lowell, Mass.
J. G. Hill	Lawrence Manuf. Co. . . .	Lowell, Mass.
J. P. Hillard . . .	American Linen Co. . . .	Fall River, Mass.
Reuben M. Hobbs .	Evansville Manuf. Co. . . .	Evansville, Ind.
John Holland . . .	Cocheco Manuf. Co.	Dover, N.H.
Stephen Holman . .	. . . . .	Holyoke, Mass.
George W. Holt, jun.	Monohansett Manuf. Co. . .	Putnam, Conn.
John Hopkinson . .	Mississippi Mills	Wesson, Miss.
Elisha H. Howard .	Harris Manuf. Co.	Providence, R.I.
Henry S. Howe . .	Pepperell & Laconia Cos. . .	Biddeford, Me.
W. H. Jennings . .	Merchants' Manuf. Co. . . .	Fall River, Mass.
D. L. Jewell . . .	China, Webs'r, & Pemb'ke M.	Suncook, N.H. .
D. W. Johnson . .	Monadnock Mills	Claremont, N.H.
D. J. Johnston . .	Harmony Mills	Cohoes, N.Y.
Russell L. Jones . .	Ascutney Mills	Windsor, Vt.
Royal Kalloch . . .	Tennessee Manuf. Co. . . .	Nashville, Tenn.
Thomas W. Kanada .	Lewiston Mills	Lewiston, Me.
Roland R. Kelly . .	Beaver Mills	North Adams, Mass.
Joseph H. Kendrick,	. . . . .	Providence, R.I.
Hervey Kent . . .	Exeter Manuf. Co.	Exeter, N.H.
John Kilburn . . .	Lawrence Manuf. Co. . . .	Lowell, Mass.

E. C. Kilburn . . .	King Philip Mills	Fall River, Mass.
H. C. Kimball . .	Blackstone Manuf. Co. . . .	Blackstone, Mass.
Richard Kitson . .	. . . . .	Lowell, Mass.
Joseph H. Knowles .	Acushnet Mills	New Bedford, Mass.
Ira F. Lawry . . .	Whittenton Manuf. Co. . .	Taunton, Mass.
Frederick A. Leigh .	. . . . .	Boston, Mass.
Thomas I. Leiper .	Irving & Leiper Manuf. Co. .	Chester, Penn.
J. Ivers Lewis . . .	Uncasville Manuf. Co. . . .	New London, Conn.
William Lindsey . .	Weetamoe Mills	Fall River, Mass.
Charles W. Lippitt .	Social Manuf. Co.	Providence, R.I.
Henry Lippitt . . .	Social Manuf. Co.	Providence, R.I.
Henry F. Lippitt . .	Globe Mill	Woonsocket, R.I.
Thos. L. Livermore .	Amoskeag Manuf. Co. . . .	Manchester, N.H.
Robert W. Lord . .	. . . . .	Kennebunk, Me.
Charles L. Lovering .	Whittenton Manuf. Co. . .	Taunton, Mass.
Henry M. Lovering .	Whittenton Manuf. Co. . .	Taunton, Mass.
William C. Lovering,	Whittenton Manuf. Co. . .	Taunton, Mass.
Augustus Lowell . .	Boott Cotton Mills	Boston, Mass.
J. S. Ludlam . . .	Merrimack Manuf. Co. . . .	Lowell, Mass.
Alvan S. Lyon . .	Durfee Mill	Fall River, Mass.
W. H. Magee . . .	Berkeley Mill	Ashton, R.I.
Albert T. Mansfield .	Allendale Mills	Allendale, R.I.
Albert G. Martin . .	Exposition Cotton Mills . .	Atlanta, Ga.
Rufus A. Maxfield .	Nashua Manuf. Co.	Nashua, N.H.
Thomas Mayor . .	. . . . .	Providence, R.I.
Robert McArthur .	Grosvenor Dale Co.	No. Grosvenor Dale, Conn.
Richard McCarthy .	Anniston Manuf. Co. . . .	Anniston, Ala.
W. E. McCoy . . .	Riverside Mills	Augusta, Ga.
James E. McCreery .	Granite Mills	Fall River, Mass.
Charles D. McDuffie .	Manchester Mills	Manchester, N.H.
Fred. C. McDuffie .	Everett Mills	Lawrence, Mass.
James H. McMullan,	. . . . .	Biddeford, Me.
Timothy Merrick .	Merrick Thread Co.	Holyoke, Mass.
Oliver H. Moulton .	Hamilton Manuf. Co. . . .	Lowell, Mass.
J. Turner Morehead .	. . . . .	Leaksville, N.C.
W. H. Munroe . .	Thistle Mills	Ilchester, Md.
A. F. Nagle . . .	. . . . .	Chicago, Ill.
John H. Nichols . .	Dwight Manuf. Co.	Boston, Mass.
Charles Nourse . .	Social Manuf. Co.	Woonsocket, R.I.
Franklin Nourse . .	York Manuf. Co.	Saco, Me.
E. H. Nutting . .	Hooksett Manuf. Co. . . .	Hooksett, N.H.
George H. Nye . .	Laurel Mills	Laurel, Md.
John Oldfield . . .	Yarmouth Duck & Yarn Co. .	Yarmouth, N.S.
John C. Palfrey . .	Manchester Mills	Boston, Mass.
Francis J. Parker .	Monadnock Mills	Boston, Mass.

Walter E. Parker	Pacific Mills	Lawrence, Mass.
John H. Parks	New Brunswick Cotton Mills	St. John, N.B.
Theo'lus Parsons, jun.	Lyman Mills	Holyoke, Mass.
Charles S. Peach	Freeman Manuf. Co.	North Adams, Mass.
William D. Pennell	Lincoln Mill	Lewiston, Me.
Haven C. Perham		Lowell, Mass.
John M. Pevey		Lowell, Mass.
Moses Pierce	Norwich Bleachery	Norwich, Conn.
Thomas F. Plunkett,	Union Manuf. Co.	N. Manchester, Ct.
H. L. Pratt	Canada Cotton Manuf. Co.	Cornwall, Ont.
Thomas Pray, jun.		Boston, Mass.
J. E. Prest	Wampanoag Mills	Fall River, Mass.
A. M. Pulsifer	Barker Mill	Auburn, Me.
J. M. Pusey	Delaware Mills	Wilmington, Del.
T. G. Ramsdell	Monument Mills	Housatonic, Mass.
Robert Redford	Arlington Mills	Lawrence, Mass.
James Renfrew, jun.	Renfrew Manuf. Co.	Adams, Mass.
Roscoe C. Reynolds		Lewiston, Me.
John Rhodes		Millbury, Mass.
F. H. Rice		W. Boylston, Mass.
Howard Richmond	Crompton Co.	Providence, R.I.
A. Robeson	Fall River Print Works	Brookline, Mass.
William F. Salmon	Lowell Hosiery Co.	Lowell, Mass.
H. Saltonstall	Pacific Mills	Boston, Mass.
Wm. G. Saltonstall	York Manuf. Co.	Boston, Mass.
Eugene H. Sampson,	Everett Mills	Boston, Mass.
Arnold B. Sanford	Globe Yarn Mill	Fall River, Mass.
Benjamin Saunders	Harbor Manuf. Co.	Nashua, N.H.
J. H. Sawyer	Newmarket Manuf. Co.	Boston, Mass.
John Scott	Willimantic Linen Co.	Willimantic, Conn.
John C. Sharp, jun.	Canoe River Mills	Taunton, Mass.
E. M. Shaw	Great Falls Manuf. Co.	Great Falls, N.H.
Thomas S. Shaw	Suffolk Mills	Lowell, Mass.
George E. Sherman	Peabody Mills	Newburyport, Mass.
Charles M. Shove	Granite Mills	Fall River, Mass.
George H. Simmons		Ansonia, Conn.
James B. Siner		Lawrence, Mass.
A. C. Slater	Linwood Mills	Whitinsville, Mass.
Robert R. Smith	Greenwoods Co.	New Hartford, Ct.
S. S. Spencer	Conestoga Steam Mills	Lancaster, Penn.
James C. Stanley	Greenwoods Co.	New Hartford, Ct.
Wilbur A. Stiles	Victoria Mills	Newburyport, Mass.
J. M. Stone		N. Andover, Mass.
Joseph Stone	Pacific Mills	Lawrence, Mass.
Henry D. Sullivan	Naumkeag S. Cotton Co.	Salem, Mass.
George P. Taylor	Lancaster Mills	Clinton, Mass.
E. A. Thissell		Lowell, Mass.

Chas. E. Thomas	Clinton Manuf. Co.	Woonsocket, R.I.
Edwin R. Thomas	Clinton Manuf. Co.	Woonsocket, R.I.
E. W. Thomas	Tremont & Suffolk Mills	Lowell, Mass.
William E. Trainer	Linwood Mills	Linwood Sta., Pa.
Edmund E. Truesdell,	China, Webs'r, & Pemb'ke M.	Suncook, N.H.
Albert F. Upton		Boston, Mass.
James Waring	Narragansett Mills	Fall River, Mass.
John Waterman	Warren Manuf. Co.	Warren, R.I.
J. W. Wattles		Canton, Mass.
T. B. Wattles	Chicopee Manuf. Co.	Chicopee Falls, Mass.
George W. Weeks	Lancaster Mills	Clinton, Mass.
Henry F. West	Washington Manuf. Co.	Gloucester, N.J.
Channing Whitaker	Mass. Institute Technology	Boston, Mass.
Nelson D. White	N. D. White's Mills	Winchendon, Mass.
W. J. Whitehead	V. Hudon Cotton Manuf. Co.	Hochelaga, P.Q.
Charles E. Whitin	Whitin Manuf. Co.	Whitinsville, Mass.
Charles P. Whitin	Whitinsville Cotton Mills	Whitinsville, Mass.
Harry T. Whitin	Rockdale Mill	Northbridge, Mass.
William H. Whitin	Whitin Manuf. Co.	Whitinsville, Mass.
A. N. Whiting	Whiting Mills	Oakdale, Mass.
William S. Whitney,	Pocasset Manuf. Co.	Fall River, Mass.
Eben Wilber	Indiana Cotton Mills	Cannelton, Ind.
Theo. W. Wilmarth,		New Orleans, La.
Thomas Wilmarth	Saunders' Cotton Mills	Saundersville, Mass.
A. L. Williston	Greenville Manuf. Co.	Northampton, Mass.
Hubbard Willson		Cordaville, Mass.
George Wood	Millville Manuf. Co.	Philadelphia, Penn.
William B. Wood	Continental Mills	Boston, Mass.
C. J. H. Woodbury		Boston, Mass.
Daniel Wright	Appleton Co.	Lowell, Mass.

Total number of Honorary Members 2
Total number of Active Members 245

CALL FOR MEETING.

NEW-ENGLAND COTTON MANUFACTURERS' ASSOCIATION.

BOSTON, April 10, 1884.

DEAR SIR, — The stated Annual Meeting of the Association will be held at the Massachusetts Institute of Technology, Boylston Street, Boston, on Wednesday, April 30, 1884, at ten o'clock A.M., for the choice of officers for the ensuing year, and the transaction of such other business as may properly come before it.

An Afternoon Session will be held, beginning at two o'clock.

An invitation has been extended to the Association from the President of the Massachusetts Institute of Technology, which has hospitably entertained this body for so many years, to visit and inspect the various departments of the Institute. The instructors will give full facilities for information as to the practical workings of their several departments. The Board has accepted the invitation on behalf of the Association, and designates eleven A.M. as the hour for proceeding on the tour of the buildings.

The subject assigned for discussion upon re-assembling is, "TO WHAT EXTENT CAN DRAWING-FRAMES BE DISPENSED WITH TO ADVANTAGE?"

By request of the Board of Government, the discussion will be opened by Mr. E. R. HANDY of Manville, R.I.; and other speakers have been invited, and have promised to take part.

The Board strongly urges that members familiar with the subject shall give to the Association the benefit of their experience.

By direction of the Board of Government,

AMBROSE EASTMAN,
Secretary.

PROCEEDINGS.

In accordance with the foregoing notice, the annual meeting of the New-England Cotton Manufacturers' Association was held at the Massachusetts Institute of Technology on April 30, 1883, at ten o'clock A.M., the meeting being largely attended.

The chair was occupied by the President of the Association, Mr. William C. Lovering of Taunton, who called the meeting to order, and requested the Secretary to read the call for the meeting.

The call was read by the Secretary.

The President. The next business in order is the reading of the records of the last meeting.

It was moved and seconded that the reading of the record of the last meeting be omitted. This motion was carried.

The President. The next business in order is the election of officers for the ensuing year.

On motion, it was

Voted, That the Chair appoint a committee of three to nominate officers for the ensuing year. The Chair appointed Messrs. W. F. Goulding, Hervey Kent, and F. A. Leigh as such committee; and the committee retired for consultation.

The annual reports of the Secretary, Treasurer, and Auditor were then read by the Secretary, and, on motion, were accepted, and ordered placed on file.

The committee on nominations returned, and reported that they had placed in nomination the present board of officers, without change.

On motion, the report of the committee was accepted.

It was moved and seconded that Mr. Goulding, the chairman of the committee, be instructed to cast one ballot for the list of names reported. Motion carried.

Mr. Goulding, in accordance with this motion, cast his vote for the full board of officers; and they were declared elected.

The Secretary, by request of the President, then read the following list of applicants for membership, who had been recommended by the Board of Government for election, naming the members by whom they were nominated; and, by vote upon each applicant singly, they were admitted to membership in the Association: —

J. H. Russell	Easthampton, Mass.
John Oldfield	Yarmouth, N.S.
Thomas H. Smith	Jamestown, N.Y.
Albert G. Martin	Atlanta, Ga.
Albert S. Mansfield	Allendale, R.I.
W. A. Barrell	Lawrence, Mass.
Ambrose J. Nichols	New Market, N.H.
John Waterman	Warren, R.I.
E. W. Thomas	Lowell, Mass.

The Secretary stated that Mr. P. J. Congdon of New Bedford, Mass., asked leave to withdraw from the Association; and, by vote, his request was allowed.

The Secretary read a communication from Messrs. G. & A. W. Harris of Providence, R.I., inviting any of the members of the Association to visit their establishment.

The President stated that the Association had been invited by the President of the Massachusetts Institute of Technology, whose hospitality they had for several years enjoyed, to visit and inspect the various departments of the Institute; and that the Board had accepted the invitation on behalf of the Association, and appointed eleven A.M. as the time to proceed thereupon.

The President. As the hour of eleven has not yet arrived, I will ask your attention to Mr. Jefferson Higgins, who has something to explain in connection with the Collins water-wheel.

Mr. Jefferson Higgins, Dodgeville, Mass. This is an arrangement to overcome the difficulty on the gate of the Collins, or any other, wheel that uses the register gate. Some of the Collins gates are provided with an inner and an outer series of balls, which run in grooves on the top of the guide, and a corresponding groove on the under side of the gate. These balls are very troublesome, getting together, and wearing out the

grooves, causing the gate to hoist and close hard. You will see, upon examination of this model, that the adjustable truck is arranged to run upon a steel track, formed in such a manner, that, when the gate is closed, the gate fits closely upon the disk of the wheel, making a water-tight joint, thereby saving any leakage. It has been in operation on an eight-foot wheel at Forestdale cotton-mill for eighteen months. They claim that they could not do without it. Where it formerly took three men to hoist and close the gate, one can handle the gate with ease. It can be handled by a lighter governor, and gives an evener speed, thus increasing production.

In front of each truck is placed an arrangement to keep the track free from all sediment, thereby insuring the shutting of the gate tight.

We are perfecting the same arrangement to be put upon bulkhead gates. I will leave this model here for you to examine, gentlemen; and, if any one is troubled with a badly operating gate, I think he will find it to his advantage to examine this model, as it speaks for itself.

The committee appointed at the last meeting to examine and report in regard to a new cotton-gin, were called upon for their report.

Mr. D. J. JOHNSTON. It is only the great interest which I think every cotton-manufacturer is likely to feel in any change in the mode of preparing cotton, that leads me to say any thing in relation to this new gin; although chairman of the committee appointed at the last meeting to examine and report in regard to it.

The committee received notice that the gin was ready for their inspection; and they visited the shop, but found that it was not in just that condition which it should have been in when presented for examination and report. And yet the committee saw enough to have their interest increased in this new gin.

It is a new departure — there is no question about that — in the ginning of cotton. It has in it the essentials for ginning the cotton, and delivering it in very much better condition than it is possible for the saw-gin to do.

As to quantity, the committee was not able to judge, on account of the incomplete condition of the gin, which required some changes to be made to render it what they said would be

perfect. The builder made some explanations as to why the gin was in that imperfect condition, and suggested changes that were to be made; but, as those changes had not been made at the time of the committee's visit, they thought it best not to go into any elaborate report in regard to it: but from their observation of the cotton that was ginned in their presence, and the manner in which the gin took hold of it, they are prepared to state that it is a very great improvement; that the staple is not cut as often and as generally as with the saw-gin; that it gives the staple very much the appearance of being drawn away, avoiding many of the serious defects which there are in the saw-gin, but which cannot be got rid of, because there is no other gin which will do the quantity, at the same time having the advantages of the roller-gin, which draws the lint from the seed, and delivers it in the natural condition.

The committee had procured a bale of seed-cotton from a plantation in Arkansas, for the purpose of experimenting on this new gin; but from some delay on the railroad (it had not come two hundred miles in ten days) it had not reached Rhode Island when we arrived there. So we had not an opportunity to judge of the merits of the action of the new gin upon this cotton, or to compare the cotton treated by it with saw-ginned cotton, which they had from the same plantation.

I think there is enough in it to make it of interest for the manufacturers to consider whether they can have this gin so perfected, or the new principle in it so extended, that they can get its advantages sufficiently recognized to induce the planters to take hold of it, and gin their cotton on this gin instead of the saw-gin. If so, I think there will be a great advance in relation to our low and poor cotton, of which there is now so much complaint.

Mr. Edward Atkinson. In respect to this particular subject, I must express my gratification that so practical a man as Mr. Johnston indorses this machine, which the theorists of the Association have been following for twenty years, — ever since it first appeared in a dentist's office at the South End.

In visiting the Institute of Technology this morning, the object of dividing this Association into three squads is, that there shall be no crowding in any one place. Although the visits will be to specific buildings at the start, it is expected

that each squad will go through each of the three buildings; and by this arrangement a crowd will be avoided at any particular point.

In the basement of this building you will find the mining laboratory in process of reconstruction; and you will find the mechanical engineering department, which I trust will be the germ of the future Textile Laboratory.

Since our last meeting, the Lowell Machine-shop has presented two roving-frames and a spinning-frame; the Mason Machine Company, a mule; the Whitin Machine Company, a card, for which the cloth was presented by A. White & Son of Leicester; the Saco Water-power Machine-shop, a drawing-frame, built for me many years since, on condition that it should ultimately go to the Institute, so that accurate observations might be made. In the shops you will find looms from the Crompton Company, from Thomas & Co., from Knowles, and from others. And this may be said, if we can beg or borrow money enough to construct a building at the end of the Providence Railroad lot to contain the apparatus of the Textile Laboratory, there will be little difficulty in filling it with machinery without expense to the Institute.

I beg leave to submit two resolutions, which I will call up by and by, — one in reference to this subject of the Textile Laboratory. A special committee upon this matter was appointed at the last meeting; but some of the gentlemen upon that special committee could not serve, and I suppose that committee has lapsed with the year in which it was appointed.

I now propose that the Textile Laboratory question be referred to the Board of Government, for such action as they may deem expedient. We have had all the machinery contributed that we have asked for, and several contributions in money have been made. But this project will not whistle itself. It must rest until there is a demand from the textile manufacturers for its establishment.

I will also call up the following resolution: That the Board of Government may, at their discretion, establish a series of observations in respect to the varying conditions of humidity and electricity in cotton-mills, employing experts thereto if expedient.

Voted, That the assessment of this year may be ten dollars per member, and that the Government may make such appro-

priation as may be prudent to carry out the purpose of the foregoing vote.

I think it has become clear that no solution of the question of humidity and electricity can be reached until there is a series of experiments made in different parts of the country in regard to this matter. Professor Agassiz once said, in answer to a question as to what he had accomplished in this country, that he had taught four men to observe. I think there is a larger number of men than that in this Association competent to observe in this matter, accurately and intelligently; and such observations may afterwards be compiled and used as the basis of a science of humidity and electricity.

On motion of Mr. Atkinson, it was voted, that, when the meeting should adjourn, it adjourn to meet again at two o'clock.

On motion, it was voted that the report of the committee on cotton-gins be accepted, and be referred back to the same committee.

At this point the meeting adjourned, for the purpose of allowing the members of the Association to visit the Institute of Technology.

Afternoon Session.

The President. The subject for discussion is as follows: To what extent can drawing-frames be dispensed with to advantage? Is it your pleasure to take up the discussion of this question now?

On motion, it was voted to proceed with the discussion of the question.

The President called upon Mr. Handy, who read the following paper: —

DRAWING-FRAMES: TO WHAT EXTENT CAN THEY BE DISPENSED WITH TO ADVANTAGE?

BY MR. E. R. HANDY, MANVILLE, R.I.

Before we take up this question for argument, we would like to spend a few moments of time in considering the origin of the drawing-frame, why it was invented, and what were the advantages then obtained by its use. We say what were the advantages; as we believe that whatever benefit may have been obtained from this machine in times past is not at the present day realized to that extent that many suppose, in those mills arranged with modern machinery; and our argument will show, as we believe, that this is the fact. If we go back to that time when the art of cotton-spinning was, as we may say, in its infancy, we shall find the condition of the machinery and the mode of handling the cotton, and preparing it for spinning, was very different from that at the present day. The process of preparing the lap for the carding-engine was then in a very crude state: the pickers or lappers were constructed without any fans or other means for drawing the cotton to cages or screens, but depended entirely on the beaters to perform this part of the work; in consequence of which the cotton was put there very unevenly and irregularly: also, the machine was not arranged with any contrivance by which the quantity of cotton delivered by the feed-rolls to the beaters could be regulated, but depended entirely on the person operating the machine to do this part of the work. If we take these prominent faults into

consideration, as well as the general construction of the machine, we will readily see that the condition of the lap, its uniformity of weight, evenness, and appearance, must have been at a low state, and very poorly prepared to be delivered to the carding-engine; and now, if we will also take into account the construction of this machine as it was in those days, I think we shall also find that it was as poorly constructed, and fully as incapable of performing good work, as the machine preceding it.

The cylinders and doffers being composed of wood, and, of a consequence, subject to all changes and variations of the atmosphere, made it almost an impossibility to set and keep the two surfaces, the cylinder and doffer, in positions to insure good work. The great inferiority of the clothing, as compared with that of to-day, was also another detriment to the performance of good work by the card. We have thus far traced the progress of the cotton in its first two processes, and shown that the condition of the machinery, as it was in those days, made it an impossibility to produce a uniform and even sliver as delivered by the carding-engine. The question then was, what was to be done with such a sliver? Our system, combining a number of cards into a railway trough delivering to a railway head, and there subject to a roller-draught, had not then been invented. It would not do to take the sliver, as then delivered by the card, direct to the slubber-frame. Its condition would not allow them to do this. And it would have been very doubtful if they ever would have succeeded in getting it much farther if they had done so.

To bring the sliver to a more uniform state before subjecting it to the slubber-frame, a machine was invented called a "drawing frame." Its office was to take the sliver, as then delivered by the card, into a can, and combine two or more such slivers into one, and pass this through a set of rolls; by which the sliver was drawn out and extended a certain amount. This process was repeated through one or two such machines, and the sliver then delivered to the slubber-frame.

Now, what was gained by this process was, that the sliver, as then delivered by the drawing-frame to the slubber, was more even, and the fibres were laid more nearly parallel with each other, than when the sliver was delivered by the carding-engine. The repeated doublings and drawing of the drawing-frame accomplished this result; and the sliver was more even, and in

better condition to be made into yarn, than when delivered by the carding-engine. And this is what we think the drawing-frame was invented for: to take the uneven sliver as it was then delivered by the carding-engine, and, by repeated doublings and drawings, to reduce the sliver to more uniformity, and to lay the fibres of the cotton parallel with each other. Now, this the drawing-frame did to a certain extent, and these were the advantages then obtained by its use. But were there any disadvantages caused by its use? By this we mean, was the cotton-sliver injured in any way? We believe it was, and is to-day; and that the cotton-sliver is injured, to a certain extent, between the carding-engine and the slubber-frame.

Now, as the cotton-sliver, leaving the carding-engine, passes through only two different machines before reaching the slubber-frame, — the railway head and drawing-frame, — it is reasonable to suppose that whatever injury may be done to the cotton-sliver, is done in one of these machines, or in both; and we believe, that, with the present system of drawing-frames, full as much injury is done to the cotton-sliver in the railway head as in the drawing-frame. And why? If we take, for illustration, the weight of the sliver as it leaves the railway head in many mills where drawing-frames are used, we will find it will be anywhere from ninety to a hundred and twenty grains per yard, and the draught of the railway head from three and a half to four. Now, if the weight of the sliver leaving the railway head is a hundred grains per yard, and the roller-draught four to one, we will have a sliver weighing about four hundred grains per yard for the rolls of the railway head to draw; and if we take into consideration the great difficulty of drawing such a heavy sliver evenly, the excessive weight required on the top rolls, and also the imperfection in the covering of the top rolls, we think it will be quite plain that a good deal of poor work is and must be done on the railway head. Now, if this sliver, weighing a hundred grains per yard, is passed to the first drawing, and there doubled two or three into one, and also subjected to a roller-draught, we will find still more harm done to the cotton-sliver from the same causes as in the railway head; viz., the impossibility of drawing such a heavy sliver, the heavy weighting and the imperfect covering of the top rolls. But it may be urged that the drawing-frame, by repeated doubling and drawing, evens the sliver, and lays the fibres parallel with

each other; and that whatever harm may be done by the top rolls is more than counterbalanced by the good obtained by these repeated doublings and drawings of the cotton-sliver in the drawing-frame. Now, this would be the fact if the sliver, as it is now delivered by the carding-engine or railway head, were of the same condition as it was when the drawing-frames were first used; but this is not the fact. The great improvements that have been made in cotton-opening machinery and lap-machines, by which we are enabled to produce a lap of which the variation in evenness of one yard with another will be reduced to almost nothing throughout the entire lap,—such a lap used in the carding-engine of to-day, which I think you will all admit is a great improvement over the card used forty or fifty years ago,—enables us to produce a sliver at the carding-engine that will be very even and regular; and the fibres of the cotton will be found to be in a more natural state, and the sliver full as even as when passed through two or three heads of drawing-frames.

But it may be also argued, on the other hand, that it is possible to produce a sliver at the carding-engine that will be as even and regular as it is after passing through the drawing-frame; that the fibres of the cotton will not be laid parallel with each other; and that yarn made from such a preparation will be found to be rough and uneven, and not adapted to be used in the manufacture of cotton cloth, where the quality is any object.

In reply to this, we would say, that, while the drawing-frame does straighten the fibres of the cotton to a certain extent, this straightening of the fibres of the cotton by the drawing-frame is done with a loss to the running of all succeeding machinery; that is, the more the cotton-sliver is passed between the drawing-frame rolls, the more difficult it becomes to work such a sliver in the succeeding machinery. Why? Because the repeated drawing of the cotton-sliver in the drawing-frame does, to a certain amount, straighten the cotton-fibre itself,—so much so that we have frequently noticed, that where a cotton-sliver has been passed through three heads of drawing, and enters the slubber-frame weighing as high as eighty-five grains per yard, such a sliver will very often fall apart, by its own weight, between the can and the bite of the rolls on the slubber; also, we do not believe that this straightening of the cotton-sliver in

the drawing-frame does by any means improve the quality of cloth manufactured.

We have thus far represented to you why, in our judgment, the drawing-frame was invented, the advantages derived from its use, and also the injury done to the cotton-sliver by its use; and we will now take up the original question, "To what extent can the drawing-frame be dispensed with to advantage?" If a cotton-sliver can be delivered by the carding-engine, that will be as even as when passed through two or three sets of drawing-frames, why would it not be an advantage to take the sliver direct to the slubber-frame without any intermediate processes of railway heads and drawing-frames? We do not believe this can be done to advantage, and in such a way as to obtain good results. If the sliver were taken direct from the carding-engine to the slubber-frame, it would require a large number of cans, and a great deal of carrying and handling of the same; also, the variation of the weight of the sliver, before and after the stripping of the cylinder of the card, would certainly make poor work; and, further, the impossibility of producing, to good advantage, any doublings whatever between the carding-engine and the slubber-frame would make, in our judgment, the idea of taking the sliver direct from the carding-engine to the slubber-frame entirely impracticable.

For an illustration of the extent to which drawing-frames can be dispensed with, we will take, for example, the Manville Mills, Manville, R.I. These mills contained, a few years ago, two heads of drawing-frames, 156 deliveries, 2 into 1. The mills are now running entirely without the use of drawing-frames, and we believe that we have certainly dispensed with their use to good advantage; and let us see why. First, how has this change been made? With the use of the drawing-frame, the railway head sliver weighed 112 grains per yard, doubling 2 into 1 on first drawing, with a roller-draught of $2\frac{83}{100}$, 2 into 1 on second drawing, roller-draught 3, and weight of sliver delivered to slubber-frame, 52 grains per yard. By doubling the deliveries of the railway heads, and by a change in the weight of the lap and draught of the cards and railway heads, the sliver weighs, as it now leaves the railway head, 53 grains per yard, and is taken direct to the slubber-frame without any intermediate processes of drawing-frames. We find, by a careful examination of the sliver as now delivered by the railway head, as

compared with that of the drawing-frame, that the cotton-fibres of the sliver, as now delivered by the railway head, are as nearly parallel with each other as those delivered from the first drawing-frame; and the reason for this is very plain, as the sliver leaving the railway head, when drawing-frames were used, weighed 112 grains per yard, and the roller-draught was 4 to 1, making a sliver of about 448 grains per yard for the rolls of the railway heads to draw. With the present weight of sliver 53 grains per yard, and the railway draught 3½ to 1, the rolls of the railway head are now drawing a sliver weighing about 185 grains per yard, which is not equal to one-half the weight of the sliver that was run when drawing-frames were used. In consequence of this light sliver in the railway head, the rolls are enabled to perform their work to a much better advantage than they were when a sliver weighing 448 grains per yard was used on the railway head. Moreover, the sliver, as it now leaves the railway head, is very much evener than it was when it weighed 112 grains per yard, for the reason, that, when this heavy sliver was run in the railway head, the rolls were unable to draw the sliver evenly, and were obliged to be weighted very heavily to do the work required: whereas now, with the light sliver weighing only 53 grains as it leaves the railway head, the weight on the top rolls has been reduced very nearly one-half; and this, with the light sliver now run, enables the rolls to draw the sliver evenly and easily. The result is, we have a sliver that is as even and regular almost as it is possible to be, and, without any doubt whatever in our minds, is very much evener than it was when it left the second drawing. Now, with this even sliver, it would naturally be expected that the running of the succeeding machinery would be improved, and the production be increased; and such we find to be the fact. The improvement in the running of the speeders has been very great: and the slubbers, intermediates, and fly-frames run much better than they did when drawing-frames were used; as, for illustration, we are running the spindles on our 6 x 4½ fine roving-frames, on ten-hank roving, 1,600 revolutions per minute; the frames contain 184 spindles each, and one hand easily runs two speeders. We are running the spindles on our 4½ x 3¾ fine roving-frames on fifteen-hank roving, 2,000 revolutions per minute: the frames contain 204 spindles each. In the spinning-room the work also runs much better, and we are enabled to get a larger

production per spindle than we could when drawing-frames were used. In regard to strength and evenness of yarn, we find that yarn made without the use of drawing-frames is stronger and evener, and that the variation in numbers between one bobbin and another is not so great as when drawing-frames were used.

And now, one word in regard to the amount of doublings in the mill: we believe it is an opinion held by some, that, the greater the amount of doublings in a cotton-mill, in such proportion will the evenness and strength of the yarn be increased; and, as the drawing-frame is the most convenient place to get these doublings, it is usually done on this machine. Now, we believe that this idea is wrong, and for this reason: if the cotton-sliver leaves the railway head in an uneven condition, then passing it through any number of drawing-frames with any amount of doubling will not bring this sliver to an even condition, as the tendency of the drawing-frame is rather to injure the cotton-sliver than to even it. We had, when drawing-frames were used in the mill, 343,952 doublings. The amount of doublings without the use of drawing-frames is 124,416, or 219,536 less doublings than when drawing-frames were used; the amount of doublings leaving railway heads with drawing-frames was 5,368; without drawing-frames, 7,776, or 2,408 more than when drawing-frames were used. Now, this fact, taken into account also with the light sliver run on the railway heads, enables us to produce the even sliver that we do at the railway head. Now, what have we gained by all this change? We have, first, been able to make stronger and evener yarn, have increased our production, and have improved in the running of the machinery. Second, by dispensing with the use of the drawing-frames, we have also done away with the help required to operate them; and, as we have not increased the number of hands we had on the railway heads when drawing-frames were used, we save the labor of all the hands employed on the drawing-frames, which amounted to about $60 per week, or $3,000 per year: the saving in the cost of top-roll covering is also quite large. We have, it is true, increased the number of railway-head rolls; but as the weight on them has been lessened almost one-half, and a much lighter sliver is run between them, we find that the cost of keeping the railway-head rolls in repair has not been increased over what it was when drawing-frames were used. To

keep the top rolls in good order on the drawing-frames we had in use, cost about $374 per year; which we now consider as so much gain, in addition to the saving in power. To drive the drawing-frames we had in use, required about 1 horse-power to each 5 deliveries, or 31 horse-power for 156 deliveries. We have increased the deliveries of the railway heads by adding 14 deliveries; and, if we estimate the power to drive each delivery as 1 horse-power, we will find that we use 17 horse-power less than we did when drawing-frames were used. If we allow $50 as the cost of 1 horse-power per year, we have a saving of $850 per year in dispensing with the use of drawing-frames, making the total amount of saving or gain $4,224 per year: to this amount, we should also add the saving in oil, waste, and supplies, and, in the equipment of a new mill without the use of drawing-frames, the saving of first cost of machinery, and the space that it would occupy.

Mr. Edward Atkinson. I do not intend to take up any time on this subject. Some of you are aware that I have submitted some views occasionally on dispensing with drawing-frames.

But, to the end of determining what the effect of different processes may be, I procured several samples of yarns and fibre from the cards, and placed them in the hands of Mr. Pray, in order that some use might be made of them by him in explaining what he has done in examining the fibres of cotton in different conditions. I should not have asked Mr. Pray to come here, and submit these samples, except with the hearty approval of the President.

Mr. Pray will now show a few of these samples, which have never been put into the lantern. If they give the extraordinary appearance which they give in the slides, I think you will at least have your curiosity excited, and you will be interested. Mr. Pray will describe them as he goes on. They are samples of goods which have been spun with or without the use of drawing-frames, and under varying conditions.

At this point, the room was darkened in order to show the views by the aid of the stereopticon. The different appearances produced were explained as follows: —

Mr. Pray. No. 1. This is taken from a railway sliver, 9 cards in section, 50 grains per yard, railway draught 4.20, and

is to show the parallelism of the fibres as they actually exist in the sliver. In making the photograph, any one who has used it can understand, that by the fibres crossing one another here, as in this case, the whole thing is out of focus. This is done in order to bring all that is possible within the range of the objective used. You notice fibres here at right angles to each other, and at all possible angles. All the slides numbered this way are running in this direction (across the screen). If you bear this in mind, you see them just as they are seen in the microscope.

In this case, you perceive the structure of the fibre, the difference in sizes, the imperfect fibre here; but the argument of parallelism is without foundation in fact.

No. 2. The sliver taken from the Gambrell card, newly ground, between the doffer and calender roll; taken to show the fibre. Nothing is necessary, except your own view of it. Those mountings were made by shutting the cover of the slide down on the slide, the mounting material between them, fastened by a strong clip, packed into the case, and not disturbed again until taken out and hardened at my house.

No. 3. From the Gambrell card, after it passed the calender roll, showing no parallelism. If you bear in mind the sliver is moving from one side of the screen to the other, you can make your own accounting for the peculiar position of the fibre.

QUESTION. Are these samples from the same card, at the same time?

Mr. PRAY. This was taken from the same card as the sliver that immediately preceded it, at the same time.

No. 4. Railway sliver, from section of Gambrell cards, taken from between the front roll and calender roll, at the same hour, or while that section was stopped.

QUESTION. How heavy were these?

Mr. PRAY. This sliver was 134 grains per yard, from the calender roll; and this was taken from the front roll. The fibres were fastened down in the original sheet. In other words, the edge of the sliver was broken, so that I could get a little way into it. In this case of the railway sliver, and drawing slivers, you will notice there is on each of almost all the slivers an open space: here is another opening, another line of fibres, another opening, and so on. The same thing holds true with the card sliver, by actual test. You may commence

at the right-hand side, and make the mounting of two inches, and then reach over and make a mounting of two inches further; and you will find the same thing all across the machine. That figure on the screen represents $\frac{4}{10}$ of an inch in width of the slide in every case.

No. 5. Sliver from an English card; drawing sliver from the coiler head, at the top. This is simply to ascertain the position of the fibre; but in this the two pieces of glass were shut down, while the sliver was held in position, the machine being still.

No. 6. Fine yarn spun from an English card sliver without any drawing; same card as just shown.

Mr. ATKINSON. The angles here are not very distinct. The fibres are in very short curves; they are round and round, and not parallel with each other and the axis of the strand.

QUESTION. What is the number of the yarn?

Mr. PRAY. 40 or 42 is shown here. And if you take some of 28 or 30, and I should tell you the name of the mill, there might be a mutiny here, from the simple fact, that, the harder the twist, the more fibres are antagonistic to the body. In this one here, this makes a complete reversion, and goes back. In here, the fibres are loose. This was taken only to prove the matter.

Mr. Atkinson just called attention to the fact, that, where there is more drawing, there is less congeniality between the fibres. It is very difficult to take 120 fibres in that distance, and bring them out clearly: it is an utter impossibility.

No. 7. Fifteen-hank roving; made with no drawing, on the ordinary fly-frame. Wherever any considerable drawing has been found, the fibres show just the same position, in this perfect confusion, if you choose to call it so. In other words, where no drawing is used, the fibres seem to retain almost the same position as in the card sliver. Wherever the drawing is introduced to any extent, especially where the speed is very fast, these same lines show, as they did in the sliver of the card I showed you just now. You notice there are little open places here, but they are small compared to the other from the card.

No. 8. A piece of goods made at Manville, R.I., with 104 to 112 picks to the inch, no drawing. Here, again, is the difficulty of a good projection; but you will notice the angle which the fibres form, the length of the thread, and you notice the twist exactly, and the distribution of the fibres in each thread.

No. 9. The same piece of goods, with a larger projection, in order to compare with the sliver which immediately follows it from another mill, no drawing-frames; four speeders in the mill.

No. 10. This represents a slightly coarser yarn, goods which have not so many thick appearances, made in one of the best mills in Massachusetts, one of the most successful ones, by one of the best spinners in this Association, with four processes of drawing-frames, and four speeders. That is a study in itself. If you will bear this one in mind, I will put the one previous to this back again, for comparison. Number 36 and 40 yarn. That piece of goods is 84-92 or 88-96.

No. 9 (reproduced). This will enable you to see the contrast. You notice the distribution of fibres is materially different here from that in the other one.

No. 10 (reproduced). This is exactly the same power: it is magnified the same number of times as that on the screen last.

No. 11. That is from the American system of carding, taken from one of the best mills in Lowell, and was fastened upon the sliver, between the front roll and calender roll of the railway head, and in order to get at the parallelism if any existed. That sliver weighed 115 grains, draught of railway head 3.66.

QUESTION. In which direction was the draught?

Mr. PRAY. The draught in every case was in this direction (across the screen lengthwise). The calender roll is on my side of the screen, and the front roll on the other side. In that case, there seems to be no direction to the fibre whatever. I was so much interested in this, that after I had the mounting made, and observed it, I went back to Lowell, and repeated it, bringing away three slides the second time; and each one was marked plainly on the back, the direction of the sliver; and, I am sorry to say, all four are alike.

No. 12. These slides were handed me, after I was called into the room, by Mr. Weeks; and perhaps he can explain them better than I can.

Mr. WEEKS. There are two slides, one of which represents yarn with four drawing-frames in process, and the other with no drawing-frames. This one had no drawing-frames at all: the other had four processes — merely for the purpose of showing the effect of drawing-frames on the evenness and smoothness of the yarn.

Mr. PRAY. That corroborates what I showed on a larger

scale. This is No. 25 yarn. There is no parallelism of the fibre of the cotton, not even in the yarn. That is, the parallelism is less found in our own system of carding than that of the English. In other words, the American system of handling yarn gives us more confusion of fibres in one way, less strength and less elasticity. I have asked this question here several times of the Association. I have come to the conclusion, that, wherever drawing-frames are not used, you will get the greatest amount of elasticity; and, where drawing-frames are used, you will get less elasticity, and less disposition to strength.

The PRESIDENT. Before proceeding, I desire to say that I made some experiments, hastily, but accurately I think, on No. 24 yarn. I have the results of them here, marked 1, 2, and 3. I will pass round the yarns, and, after you have examined them sufficiently, will designate them. I will say that one of these is made with two drawing-frames, one is made with one drawing-frame, and one without any drawing-frame.

QUESTION. How many doublings on each frame?

The PRESIDENT. Three into one.

QUESTION. The same number of roving in each case?

The PRESIDENT. Yes; single roving on the frames. The yarns are made from a strict low middling cotton.

We shall be glad to hear from the other side of the question, if any one has any thing to say.

A MEMBER. It is suggested that the question be turned about in this way: To what extent can we afford to use drawing-frames? — instead of asking how far we can dispense with them.

Mr. O. S. BROWN. Mr. President, after seeing the illustrations upon the screens, I think there is no argument to be added. I think the question just suggested is the one to be discussed. As to dispensing with the drawing-frames, I have never tried it on any large number.

Mr. LEIGH. Some five years ago this question of dispensing with drawing-frames was raised, and I really thought at the time that there was something in it. I happened to be going across the water, and thought, before deciding the matter in my own mind, I would look around, and see what they were doing there, in places where they were operating some of the largest mills. I went into several mills, containing seventy thousand to eighty thousand spindles in one building, spinning thirty-twos, warp, and forty-sixes, filling, for print-cloths.

In the mills which I went through, I noticed that certain changes had been made since I was there seven years before. The first change I noticed was, that there were more lappers than I had ever seen used there before, doing less on each machine, putting the cotton through an opener, and then three single-beater lappers, the last two having eveners. The cotton was better prepared, and the carding much better, than formerly. When I got to the drawing-frames, I noticed the same system as adopted for many years, — three drawing-frames doubling six into one at each operation. These frames were going slower. Instead of producing one thousand pounds per delivery per week, they were reduced to eight hundred pounds.

I questioned the manager of the mill, and said to him, "It seems to me that this is entirely wrong: we have done away in America with all but one set of drawing." He said, "Let us look at these drawings." I saw the slivers coming through, six into one, the sliver weighing about 50 to 60 grains per yard, *all under one boss*, coming into a trumpet at front. I noticed the condition of this sliver. Then we went to the second drawing, — six into one, as before; I noticed it was much smoother: then to the third drawing, six into one, and that was smoother still. I remarked that in America drawing-frames were being dispensed with, and stronger yarn obtained. He said they had tried it there, but could not get that result. I then went to the roving-frames, and noticed they were running them slower. Frames with 7″ x 3½″ bobbins, formerly run twelve hundred revolutions per minute, were reduced to under a thousand.

I expressed my surprise at this; but he assured me they got nearly as much work off, and kept out single, and got the benefit in their spinning, which was running faster than I had ever seen it before.

When I looked at the cost of production, and what they were doing, the result was very satisfactory.

I pursued my investigation into the finer numbers, ranging from 60*s*. to 200*s*. in Bolton, and found the general system there, where they used combers, was *four sets* of drawing, — one before the combers, and three afterwards. This was the general system; but there was one mill there that had *six* sets of drawing, and *two* sets of roving, frames. This mill was spinning from 60*s*. to 120*s*., and was running better than any other mill I saw.

In thinking the matter over, I came to the conclusion, that in America, by using a railway, you are committed to a very heavy sliver to begin with. I think it is impossible to draw a sliver of a hundred grains per yard properly. It separates the rollers, — the bottom roll is driven: the top roll is not only *not driven*, but is heavily weighted besides, making it impossible to draw properly. I had made up my mind, that to attempt to draw one sliver of a hundred grains with a single boss was ridiculous; it could not be done: so, to compromise the evil, I put three together. Suppose my roll was six inches long, and my sliver one inch wide, I should only have one inch of driving-surface; but suppose I got three slivers under the roll, I get three inches of driving-surface, and I manage to get the rolls to draw the sliver "in a fashion." In other words, suppose my slivers were 100 grains per yard, I would take three, and draw five, I should get a 60-grain sliver delivered at first drawing. Then I should take six of these slivers, and draw six, bringing them out 60 grains again. In that way I could draw the slivers; but to attempt to draw a sliver of a hundred grains, and *separate my rolls*, I should get into difficulty. I think, if you use drawing-frames properly, as by bringing the sliver at first instance from the railway head about seventy grains, you can begin to draw it.

In the process described in Mr. Handy's paper, he had too heavy a sliver at railway head. The advantage he gains, is, first, by turning his drawing out, and, next, by lightening his railway head sliver one-half. Now, if he had done that first, and kept his drawing, he would have had a better result. The trouble is in attempting to draw too heavy a sliver through one roll; which is more than you can do, with the driving-surface which you have, under these conditions.

In all the experiments I have tried here, I have arranged as described, and find that the work has been better done, and the character of the yarn greatly improved.

Mr. Greene. I would like to hear from Mr. Davis.

Mr. Atkinson. The peculiarity of the English system, I think, on my own observation, is in the very light weight of the strands, and the consequently less weight on the top rolls, and more perfect work in each process of drawing wherever the draught may be made. My attention was called to the subject more particularly in a mill which had been spinning yarn

to be used as a warp, with lustred wools, which required a smooth, strong, polished yarn. But when the fashion changed to the light, soft woollen goods, and they needed a warp for these goods which would take color uniformly with the soft wool, this gentleman was obliged to throw out all his combers, and put back English cards, and dispense with a considerable portion of his drawing; and in that way he got a soft, strong warp which would take color, when dyed, above most of the yarns made in England.

Now, Mr. Dempsey has named a lower kind of goods which come to him, which are perfectly easy to bleach and finish. He says the mill is one in which no drawing-frames are used.

I should like to call on Mr. Wattles to say a word, if he will, about this English system, — he having taken charge of a mill going in English fashion with three processes of drawing, — and tell us what use he now makes of two of them.

Mr. WATTLES. In answer to Mr. Atkinson's question, I would say, that in the Ocean Mills at Newburyport, where the English system was adopted within the last three or four years, the plan is to use three sets of pickers, — one set for opening cotton, one set intermediate, one set for finishing laps for cards. Each card has a coiler. The sliver is taken from the card to the drawing-frames, where the doubling is six to one; from the drawing-frames to the slubber, running single at slubber; from slubber to intermediate, two to one; thence to spinning, without further doubling. This process is for yarn numbering four to twelve. For yarn numbering from twelve to thirty, three processes of speeders are used, — slubber, intermediate, and fly-frame.

The PRESIDENT. In regard to these samples at which you have been looking, Sample No. 1 was made with two drawings, No. 2 with one drawing, and No. 3 without any.

Mr. PRAY. I would like to ask one question: What is the relative strength of the three different yarns?

The PRESIDENT. No. 1, made with two drawings, stood a breaking strain of 60 pounds; No. 2, made with one drawing, a strain of 62.66 pounds; and No. 3, without any drawing, a strain of 62.66, the same as No. 2. The number of the yarn is about 24.

These samples were not made as high-grade yarns, but were made of low middling stock. I tried the experiment where it

was convenient to try it, and without any desire to prove that no drawing was desirable, or the contrary.

Mr. ATKINSON. In order to try an experiment on the appearance of goods, I borrowed some warp No. 30, and borrowed some filling of a hosiery mill, made in English fashion, No. 20; and here is the fabric. The filling is No. 20, with two processes of drawing, with English cards and coilers. The warp is from a mill where no drawing is used. My theory is, that a true cloth should have a soft, spongy filling, coarser than the warp. There it is.

I may say, what Mr. Pray has brought before you I have asked him to do, as the beginning of understanding this question. He has spent four thousand dollars for the apparatus which has led up to the possibility of making these experiments. I hope the Association will find it in their way, in some manner, to take advantage of these experiments, and have objectives for the lantern extended through a long series, and not at Mr. Pray's sole expense.

Mr. PRAY. I will say a word of what I have been doing, of what I have done myself. I was working at this matter at the Atlanta Exhibition, in 1881; and Mr. Atkinson, unfortunately for me, found out what I was engaged in, and by his persistence has urged me on, and contributed very largely to my success in the matter. Not many weeks ago, he asked me certain questions, which I answered him; and I showed him the result of my investigations in this way. He suggested that I should continue them on a more extensive scale; which I declined, telling him that I was already out three or four thousand dollars, and I could not afford to go on with these investigations, and give them to the public, without getting any thing for it. Meantime, in December last, he published an article on his "Theory of the Cotton Fibre," which so coincided with my own ideas that I went to him soon afterwards; and, after conferring with him, I got up this collection of mountings for my own satisfaction, which proved an expensive matter to me, but a very entertaining one. I have shown you a dozen slides of about two hundred of this series that I have. So far as the apparatus goes, I have the only one in the world; and it cannot be bought for a hundred thousand dollars. But if the Association desires to get at any facts of this kind, paying a reasonable sum towards reimbursing me for the expense I have been at, I will willingly undertake to

furnish them. The difficulties which surround this matter can be seen in the fact that several parties have attempted it, and have failed; having taken positions which are untenable from a scientific stand-point, or point of fact. Mr. Atkinson, realizing the fact that a cotton-spinner would carry it out more successfully than a scientific man, or a photographer, has urged me to go on. I told him, "If the Association want to go on, I am perfectly willing to do it; but I cannot give you for nothing what has cost me so much." I haven't any interest in it to make money out of it. I am at work on a book on the structure of the cotton-fibre; and I propose to commend these investigations to cotton-spinners, if I live long enough to complete it, and they are willing to take it.

Mr. Leigh. Referring to the diagram on the blackboard, which shows the American system of drawing, you have three slivers coming together at the front; the distance from trumpet is greater from the slivers at each side than the centre one, which causes an unequal draught on them, and makes ragged selvages, besides the frequent breakages at front when an end is pieced up at back, as they often get through the rolls before it makes a good piecing; consequently the frame has to be stopped *twice* to make *one* piecing. This is avoided by the English system of putting the slivers under *one boss* instead of *three;* and, when an end breaks at back, the other slivers carry it through. When you get the top rolls properly driven, and the slivers not too thick to separate them, so that they are kept too far apart for the bottom roll to drive the top one, you can draw cotton properly. In the views which Mr. Pray has shown you, one is taken from the card, which always shows slivers confused; and those taken at railway head and drawing show that they are badly drawn. The slivers from roving-frame (driven at a high speed), and also from mules, show the same confused state of sliver. It is well known that the centrifugal speed of spindles in a mule has a tendency to throw the fibres out, and make a soft and woolly yarn. If Mr. Pray could pursue his observations a little farther, and take the drawing *as it should be*, he would find a different state of things: the fibres from first drawing would be much straighter, and the fibres from second drawing-frame pretty nearly parallel. The proper plan is, to get the sliver down to 60 or 70 grains from railway head, draw three or four ends in first drawing, and six into one in the second draw-

ing. I have put many drawing-frames in on this plan, and found a great improvement in the work, also a great saving in waste.

On motion, it was voted, that the Board of Government be authorized, in order to meet the expenses of the Association for the current year, to make the usual assessment, not exceeding ten dollars per member.

Mr. ATKINSON. I will call up my two resolutions now, sir.

The PRESIDENT. Mr. Atkinson offers the following resolutions: —

"*Voted*, That the Board of Government may, at their discretion, establish a series of observations in respect to the varying conditions of humidity and electricity in cotton-mills, employing experts thereto if expedient.

"*Voted*, That the assessment this year may be ten dollars per member, and that the government may make such appropriation as may be prudent to carry out the purposes of the foregoing vote.

"*Voted*, That the proposed plan of a Textile Laboratory, in connection with the Institute of Technology, be referred to the Board of Government for such action, or such report thereon, as they may find expedient."

The above were passed.

Mr. ATKINSON. I should be glad if the Association would take some action with reference to the methods of investigation adopted by Mr. Pray, of which he has given us a few illustrations to-day, and the continuance of these experiments; and to that end I make the following motion: —

"That the Board of Government be requested to consider the experiments made by Mr. Pray, of which he has presented us a few examples, and see if it is expedient to take any action in regard to their extension by this Association.

Carried.

Mr. ATKINSON. If there are any gentlemen present who were not here in time this morning to go over the Institute with us, they will be very welcome to do so any other day, and to make such examination as they see fit.

Mr. E. H. SMITH. My experience is entirely different from the experience of the gentlemen who have spoken before; and, for that reason, it may be interesting, if not useful. I have the English cards, no railway. I have four heads of drawing, making four thousand deliveries. I spin thirties and forties, sometimes as high as fifty. I don't know how these gentlemen can obtain an even thread without the drawing. I find quite an in-

equality in my yarn as it is, with four thousand doublings; and I am perfectly certain that the last delivery is much more even than the first. Whether I get a stronger thread, I don't know, with three drawings. I use good cotton; and I think, if forties will test forty-five or fifty pounds, I don't lose much strength in the yarn. My experience seems to run contrary to that of Mr. Johnson and Mr. Pray.

Mr. GREENE. I suppose it makes quite a difference whether you run one card, or ten, or twelve. If you run ten or twelve, you get quite a number of doublings. If you have only one, you need drawing more than if you run a larger number. Then it appears that many times when they dispense with drawing, they have put in another railway head, and run a lighter sliver; but if they would run the lighter sliver, and keep in the drawing, I should think that would be a good plan, — to run about eight cards, and deliver the sliver at seventy or eighty grains to the yard, instead of a hundred to a hundred and twenty.

Mr. E. H. SMITH. My present drawing weighs thirty-eight. I have a single boss over, and that dispenses with so many selvages.

Mr. ATKINSON. In respect to electricity and humidity in cotton-mills, there are men who are equally good manufacturers, and equally successful in their operations, who differ on these points, and who cannot give a good reason why they differ. They cannot give satisfactory reasons for the effects of electricity and humidity upon their materials. Here is, therefore, another call for the scientific treatment of cotton-spinning, another argument for carrying out the plan of the Textile Laboratory; so that the men who are successful shall know the reason why they are successful, and perhaps the men who are not successful will find out why they are not. We don't know any thing about this matter. There is absolutely no certain knowledge on the part of any man in this room upon the real science of drawing and twisting cotton-fibre into strands.

Mr. JOHNSTON. At the last meeting, I found a good deal of fault with regard to electricity: but I have never known less trouble from the same cause than during the last winter; and I think the principal reason is, that the cotton was very dry this year, and was very damp the year before. Having been packed and compressed while in this condition, it did not lose

its dampness: and, as it is almost impossible at the mill to give it the requisite drying and airing, much cotton had to be run through in that condition; and we were seriously troubled with electricity while working it. Last winter our cotton was dry, and we had comparatively no trouble with electricity.

With regard to drawing, and the difference of opinion that exists among cotton-manufacturers, I can hardly come to the same conclusion as Mr. Handy. We have not got the correct theory, to say nothing about the practical part of the business appertaining to the drawing and twisting of cotton. I regret that Mr. Handy did not go a little farther with his experiments. With good cotton, and an abundance of preparation, there is no difficulty in making good work. But take an old mill with ordinary cards, running at the speed at which they have to run them now to get the work out, with two or three operations of drawing and one of roving — that is very different from such a mill as that from which the samples came which were shown here to-day. Take our No. 1 carding, where we have ordinary cards running, and doffers ten to eleven, producing one and a half pounds to the inch, or over, which requires seventy-two breakers to make lap for finisher-cards, and then running twelve cards into railway head, drawing about four, then two into the first head drawing, then four into the second. A short time ago we stopped the second drawing for the filling, (fine forties), and followed the work carefully into the mule-room; and the spinning went twenty-five per cent better than with the two drawings, with the four into one. That was very well. But, when that work was followed down into the weaving-shop, all improvement stopped. What was the cause? There were tender spots in the yarn, that would break in the weaving. We tried that long enough to be satisfied that the evil was in the doubling. When we went back again, and put that second drawing to work, the evil was over: all the breaking in weaving was done away with.

In another mill, where we were not doing as much on the card, where we were having two operations of drawing, and greater care was required on account of the finer numbers (as we were making sixties and eighties), we could take out the drawing, and take out one intermediate; and we could not see the difference in the spinning and weaving.

There were two examples of the working of cotton under entirely different circumstances, in which opposite results were arrived at, apparently from the same cause. All such things should be taken into consideration in discussing this matter.

Now, Mr. Handy, in his experiments, made some comparison between the American and English modes. In the numbers Mr. Handy is making, he gets more doubling than will be attained in an English mill. Taking the numbers he makes, with single carding as the basis, and then making a comparison in his experiments between the English and American way of working, is not a fair showing, and does not give us the actual facts in relation to that matter, nor the actual deductions that we can be governed by. We want all these facts, to see what we are doing. There is a difference, whether we carry our doubling to our spinning, or whether we stop our doubling in the card-room: there is a different result. And, if there are any more experiments to be tried in ordinary mills (where we are running our cards faster), then take actual comparisons in that mill, and, by actual comparisons, carry them through.

Mr. Pray. We sometimes find a man who is running 400 looms on 28 to 36 yarns; another man is spinning No. 28 with draught of 24, and running his roller-draught at 16, 20, or, in one case, 26. Now, to a practical cotton-spinner, this may look like the boy stoning the frog; only, in this case, we take the part of the frog, and somebody else is throwing stones. Now, it seems to me, that any report, or any comparison made here to-day, is made without any reference to one or the other system, — of English or American drawing. It should be distinctly stated that Mr. Johnson has one mill using a Whiting card, another using a Leigh card. When he carries it into his system of drawing, one operates in one way, and the other in another way. He may double two into one, or three into one, in that way reducing or increasing his doublings. Another man starts with six cards in section and a railway sliver of 55 or 60 grains. Another man, starting from the same point, doesn't state that fact; and he has a sliver of 140 or 150 grains. So far as dispensing with drawing goes, I am neither for it nor against it. I have accomplished certain work here, and have shown you some of the results. Here is the English system, taking 35 grains for fine work, 60 grains for coarse work, which, drawn down here (referring to diagram on blackboard), makes a perfect

sheet. The English people, again, use drawing ten times as much as the American people, because we start here with the railway sliver. If you have ever stood by a railway head, you have noticed a varying width with the weight of the sliver. I have been almost out of patience at times, because the simple fact has never been stated on this floor: here we have a weight of 600 or 700 grains on the back side of railway head, spread over eight or nine inches. Any man that takes the shaft or pulley, and turns the slightest particle from the exact parallel line, knows the belt will run *up hill quickly*. Just the moment there is any struggling in this mass of cotton, it will run as thick as it can to the centre; and if you stop your railway head, and take out the two front rolls of the four, you find that to be the fact, and the thickest part in the middle.

(Referring to figures on the black-board.) You are trying to hold down this elliptical-shaped sliver of cotton. You are attending to your drawing here, in a semi-regular way, and tearing the edges of the piece. You take a strand from that of 108, 112, 115, all the way to 180 grains, put it under two rolls; you get three into one, out of two rolls. What is the result? You draw two, three, or four. You have got a sliver of, say, 80 grains to the yard. You put in three of these together. You can draw that sliver better at 125 turns of the roller than you can at 360 or 370 turns, as I have seen it running within the last ten days. Mr. Leigh refers to tearing these edges by irregular draught, represented by that angle all the time. The three things are all the time working just about in that shape. I don't mean to criticise any member of this Association, but I have been two or three years trying to get certain facts. I have asked questions in regard to elasticity, but I have not got any answer. But, in discussing the double draught last year, Mr. Lockwood asked me to give him definite data in regard to any experiments I tried. I said, "Certainly." Where you take a light sliver, you can draw it over and over again; but you will never approach parallelism to any great extent. A good many of you don't think that way. Take two pieces of drawing-sliver, put between two pieces of glass, and hold up to the light, and see if you can find the parallel. You will find the fibres as you see them to-day, at all sorts of angles to each other, except parallel; the more draught, the more confusion.

Now, when these things are mentioned, they should be mentioned in a tangible shape; so that the members of this Association need not ask, "What is the weight of your railway sliver?" "What is the weight of your sliver?" etc. Let us get at these facts. I have written to thirty-four mills in New England for certain facts regarding this humidity question, inquiring what day or month or year they found the most trouble; and, from twenty-seven mills, I got twenty-seven different answers. I undertook to tabulate them; and the answers were so different, that they looked like speed-diagrams of an engine, — from eighty to eighty-five, from seventy to ninety. The answers to a single question on that inquiry showed that difference.

I suggest, then, now, in the closing hour of this session, that, when we come together again, I am going to try to give you some facts on this question of dispensing with drawing. There is no man interested in it any more than I am, because I am after facts. I hope these facts will be brought out; and I know that many of you here will gladly second every thing I have said as to comparison of facts.

Mr. LEIGH. What would it cost to get photographs of drawings, three sets of frames?

Mr. PRAY. I will photograph them for you without charge, for your information, if you send me the slides.

Mr. ATKINSON. Mr. Johnston remarks that the cotton last year was very much affected by electricity, and that the cotton this winter is unaffected, and is dry. Last year, there was a very dry winter, a winter drought, with scarcely any humidity in the atmosphere: while this winter has more humidity in the atmosphere than any winter I have ever known; and I think that has perhaps more to do with the working of the cotton than the condition of the cotton itself.

Mr. JOHNSTON. I beg to say, before we adjourn, that it is due to the past and the present that we refer to the absence of one who was with us at our last meeting, — one who, by his Christian character, his uprightness in his business, and his friendship, as he met with one or another, set us so good an example as a manufacturer and as a man. It is fitting that we should pay our tribute of respect to him, now that he has gone.

I refer to Mr. A. D. LOCKWOOD, one of the founders of this Association, who signed the first call for it, who was president

of the Association, and who, by his good judgment and advice, I think has done much to make it the success it has been. I should prefer that some one who knew him better than I, and some one more capable, should bear tribute to his character; and I think we owe it to ourselves and to his memory to take some proper action in the matter. I have known Mr. Lockwood for a number of years, and I remember him with warmest affection. All who have known him, or been associated with him in business or otherwise, remember him with esteem, and warmly cherish his memory. Therefore, I move that the Board of Government place upon the record, proper resolutions, setting forth his peculiar traits and qualities, and recognizing the benefit that he has been to this Association, accompanied by an expression of the loss we feel, as an association and as individuals, in him as a man and a Christian, — a man to whom we looked up, and a worthy example, to whom the young men might often be referred.

Mr. GREENE. I offer an amendment, that a copy of the resolutions be forwarded to his family.

The above motion, as amended, was passed.

On motion of Mr. Weeks, it was voted that the thanks of the Association be presented to the Institute of Technology for its courtesy to the Association.

Adjourned.

THE following resolutions were directed, by the Board of Government, to be placed on record, as expressive of the sentiments of the Association, indicated by its vote at the annual meeting.

"*Resolved*, That by the death of our late president, AMOS D. LOCKWOOD, we are called to mourn one of the ablest and most useful projectors of the New-England Cotton Manufacturers' Association, whose lifelong devotion to the best interests of manufacturers has made his name widely and honorably known throughout the land.

"*Resolved*, That we hold in cherished remembrance his nobility of character; his earnestness of purpose; his power to organize and direct; his keen discrimination and excellent judgment in dividing the right from the wrong, the true from the false; his courteous geniality of manner; his generosity in aiding his fellow-men; his integrity and uprightness in all the relations of life; and, above all, his abiding faith in a Divine and overruling Providence.

"*Resolved*, That we heartily commend the study of his character and example, his habits and methods, to the young men of our day who are struggling to make life a success."

[No. 37.]

N.E. COTTON MANUFACTURERS' ASSOCIATION.

PROCEEDINGS

OF THE

SEMI-ANNUAL MEETING,

HELD AT

BOSTON, OCTOBER 29, 1884.

BOSTON:
FRANKLIN PRESS: RAND, AVERY, & COMPANY.
1885.

FRANKLIN PRESS:
RAND, AVERY, AND COMPANY,
117 FRANKLIN STREET,
BOSTON.

CALL FOR MEETING.

NEW ENGLAND COTTON MANUFACTURERS' ASSOCIATION,
BOSTON, Oct. 10, 1884.

DEAR SIR, — The stated semi-annual meeting of the Association will be held at the Massachusetts Institute of Technology, Boylston Street, Boston, on Wednesday, Oct. 29, 1884, at ten o'clock A.M., with an afternoon session beginning at two o'clock.

Topics heretofore discussed will still be in order if called up by any member; and, in addition, the Board have the pleasure to announce the following: —

Professor CHARLES H. FISHER, of the Massachusetts Institute of Technology, will present a report of the observations made and communicated to him from various mills, under the advice of the Board of Government, as to the influence of varying conditions of moisture, and of electricity in the atmosphere, upon the manufacture of cotton.

The following questions will then be discussed: —

First, In which of these departments of cotton manufacturing has the *least* progress been made during the last twenty years; viz., Picking, Carding, Roving, Spinning?

Secondly, How should the common 36-inch top-flat card be constructed and operated to produce the best results; viz., As to size of doffer? Size of cylinder? Speed of doffer? Speed of cylinder? Weight of lap? Draft? etc.

Several members have been specially invited by the Board to give their views upon the foregoing questions, and all are cordially invited to take part.

By order of the Board of Government,

AMBROSE EASTMAN, *Secretary.*

PROCEEDINGS.

PURSUANT to the foregoing notice, the stated semi-annual meeting of the New-England Cotton Manufacturers' Association was held at the Massachusetts Institute of Technology, Oct. 29, 1884, at ten o'clock A.M., the meeting being very fully attended.

The President, Mr. WILLIAM C. LOVERING, occupied the chair, and called the meeting to order.

The Secretary read the call for the meeting, after which the following gentlemen were elected to membership, upon nomination by various members, and recommendation of the Board of Government: —

Messrs. THOMAS C. SHELDON, Sawyer Mill, Boylston, Mass.
WARREN M. OSWELL, Phenix Mills, Shirley, Mass.
C. H. TRUESDELL, National Mfg. Co., Nashville, Tenn.

The PRESIDENT. It is perhaps known to you that the Board of Government during the past season, by direction of the Association, has made certain observations with a view to determining the varying conditions of moisture and electricity in the atmosphere in connection with the manufacture of cotton; and, in doing this, we have employed Professor Fisher of the Institute of Technology, who has devoted a large part of the summer to these observations. He is prepared to-day to give a report of his work, which, from what I know of it, will be of great interest to the Association. Before, however, proceeding with this report, I want to allude to the question first on our list for discussion after the report. The question is as follows: "In which of these departments of cotton manufacturing has the *least* progress been made during the last twenty years; viz., Picking, Carding, Roving, or Spinning?" This Association has been in existence very nearly twenty years, in fact, it enters upon its twentieth year to-day; and it was thought desirable by the Board of Government to review in some measure

the improvements that have been made during the last twenty years. It is a known fact that a great deal of machinery which has been put in during the last ten years, and even five years, has been thrown out. I speak of this now, because it is proposed to take a different course with this debate from that usually taken; and it has been proposed, at the close of the debate, to take the sense of the meeting in a ballot upon this question. Heretofore the Association has avoided balloting, or taking an expression of the sense of the meeting, upon any subject, because personal interests were so involved that it did not seem desirable; but, upon a general and abstract question like this, — In which of these departments has the least progress been made? — it may be helpful to us to take a ballot. So, unless objection is made, at the close of the debate we will proceed to a ballot. I state this in order that the gentlemen of the Association may consider the subject thoughtfully, and may be enabled to vote intelligently upon it. One reason for asking for a ballot is this, that at present, out of a total of perhaps a hundred and twenty members present, we usually hear from only fifteen, or twenty at the outside; and yet, the opinion and judgment of those men who do not lift their voice in debate is of as much value as the opinion and judgment of those who do speak. Upon this abstract question, therefore, it seems perfectly proper for us to hear from these people in this way, — in the form of a ballot. It may be argued, perhaps, that the question is of no importance, and that the result of the debate will be almost nothing; but I confess, for one, that I have great faith in the deliberate verdict of an association like this upon any question. It is for this reason that I state this before entering upon any other business, to give you an opportunity to consider the matter; and those of you who are willing to enter upon the discussion are cordially invited to do so.

You will now give your attention to Professor Charles H. Fisher of the Massachusetts Institute of Technology, who will read his report as to the influence of varying conditions of moisture, and of electricity in the atmosphere, upon the manufacture of cotton.

REPORT UPON OBSERVATIONS TAKEN IN FOURTEEN COTTON-SPINNING ROOMS, USING RING-FRAMES, IN JULY, AUGUST, AND SEPTEMBER, 1884, FOR THE BENEFIT OF THE NEW-ENGLAND COTTON MANUFACTURERS' ASSOCIATION.

BY CHARLES H. FISHER.

To the President and Members of the New-England Cotton Manufacturers' Association.

GENTLEMEN, — Early in the summer, at the request of your president, I commenced the study of the working of cotton in dog-days; and by his desire I now give you an account of the methods pursued, and the results obtained. It had been proposed to make a series of systematic observations in some such manner as those of the United-States signal service; to have them transmitted to a central station, and there arranged and studied with a view to finding out what was the cause of the admitted difficulties in the working of cotton at that season of the year.

On account of the experience of some mills working on colored goods, that at a given time one colored stock might be working very well when another was working very poorly, and that at another time the conditions might be exactly reversed, it was decided to restrict the investigation to mills on *white* work entirely.

It was also decided to have the observations taken in mills as far apart as possible in New England, to choose mills which manufactured different kinds of goods, and which used different kinds of cotton, so that as broad a view as possible might be obtained of the whole subject. The first step taken was to find out, as fully as possible, what was already known upon the subject; and it is interesting to note the extreme divergence of views of practical and successful manufacturers upon this subject. That it may be seen what these views are, I will briefly state some of the causes assigned by various gentlemen for the bad working of their mills in dog-days. One gentleman says that the high temperature prevailing is what makes the trouble; another, that the extreme dampness of the air is the cause of the mischief; another, that the presence of electricity in unusual quantities, due to thunder-storms, etc., is the harmful agent at work. Another gentleman thinks that the absence of electricity in the rooms, on account of its being more easily con-

ducted away by the unusually damp air, may be looked upon as the cause of the difficulty. One gentleman thinks there is a chemical change in the cotton, due to unusual atmospheric influences. Another says that there is a sort of softening of the cotton fibre by the combined influence of a high temperature and the water in the air; in other words, some such change as is undergone by various substances upon being boiled in water. Several gentlemen had noticed, and were positively certain, that the direction in which the wind was blowing had some effect upon the work.

As one instance, a gentleman from Fall River tells me, that, during the prevalence of a north-east wind, his work runs much better than during the prevalence of one from the south-east.

After all these reasons have been given, we are told by other manufacturers that there need be no trouble whatever in working cotton in dog-days, and even that dog-days are the best days in the year for its successful working. It was, however, admitted by some of the gentlemen who had no trouble at this time, that they were in the habit of saving bales of extra stapled cotton, as they were found in the earlier months of the year, for use at this time. This of itself seems to show that there is an admission, even on the part of these gentlemen, that cotton does not work in dog-days as it does at other times, or that operatives do not; in either case, the mill does not, and the cost is increased, either in stock or in labor.

These various opinions were evidently given with such good faith and earnestness that they merited a very careful consideration, which has, as far as possible, been given in each case.

The preparation of a plan for the taking of observations was the next step in the work; and several forms for observations were prepared, and submitted to the committee of the Board of Government who had the matter in charge, and, as the result of their aid and advice, the book as before you was prepared. This was a matter of more difficulty than would at first appear. I was not sure of the actual condition of things, and was obliged to propose observations on every conceivable point that seemed likely to have any bearing whatever upon the subject. This made a very large amount of work for the mills, and would have made altogether too much work in comparison and compilation. Consequently, your committee amended the plan according to their knowledge of what could probably be

done at the mills, and what was likely to be of use in the later study. This brought down the work of observation to an amount which has been possible for the various mills to perform, and for me to examine, not, perhaps, as completely as I could desire, but sufficiently so to obtain the results given later in this paper. This observation book consists, as you see, of a number of leaves, one of which represents one day at the mill where the observations are made. At eight A.M., twelve M., and four P.M., a number of observations are taken, and recorded in the book in duplicate. The right-hand coupon is torn off, and mailed here every third day. The form has fourteen numbered spaces for record at each of these three times per day, and opposite each of these spaces is printed the name of the observation to be recorded in it.

These are as follows: —

1. Temperature, wet bulb.
2. Temperature, dry bulb.
3. Relative humidity.
4. Barometer.
5. Direction of wind.
6. Velocity of wind.
7. State of weather.
8. Grade of cotton.
9. Average number of yarn.
10. Strength of yarn.
11. Elasticity of yarn.
12. Spinning.
13. Trouble from electricity.
14. Trouble from humidity.

Besides these, the temperature of the water in the canal or pond is recorded once a day as observation 15.

It will be observed, that, with the exception of 13 and 14, "Trouble from electricity and humidity," — observations which have not proved to be of much value, — there is but one observation upon the way in which the mill is running, and that is upon spinning. This was, in every case, verbally restricted to some one *ring*-spinning room in each mill. This was reported by the person in charge of the rooms, at the proper times, as the result of his careful judgment: he was to make no measurements at all; but he probably had it constantly in mind, that this report was to be made, and consequently observed more closely than he otherwise would have done, the differences which occurred from time to time in the room.

On the inside of the cover is pasted the following short code of directions for observers: —

DIRECTIONS TO OBSERVERS.

The wet-bulb thermometer should be placed near the exposed thermometer, both being placed where they will not be exposed to the influence of any body which is much warmer or colder than the air in the room.

They should be placed nearly at the height of the eye of the observer.

Keep the cistern of the wet-bulb thermometer well supplied with pure distilled water or rain-water. The cover should be changed and the bulb cleaned as often as necessary to keep them clean. The bulb must be completely covered with muslin and the wick. Should the muslin become dry in very dry weather, the wick should be wet directly with a few drops of water. If at any time the wet-bulb thermometer is found to give a higher reading than the exposed thermometer, examine the latter, wipe it, and make sure that it is clean and dry; then observe if the muslin cover of the wet bulb is clean and properly moistened on all sides. The readings are to be properly recorded if they do not agree. The first observation to be made is that of the exposed thermometer, and this must be made as quickly and accurately as possible.

Observations 3, 4, 5, and 6 are to be omitted.

Observation 7 is to be marked as follows: —

Thunder Storm,	1.
Heavy Rain,	2.
Light Rain,	3.
Well-marked Fog,	4.
Sky two-thirds or more clouded,	5.
Sky from one to two-thirds clouded,	6.
Sky less than one-third clouded,	7.

Observation 8 is to be reported as showing where the cotton was grown.

Nine is self-evident.

The remainder of the observations, 10, 11, 12, 13, and 14, are to be marked on a scale of five as follows: —

Very poor conditions,	1.
Poor conditions,	2.
Fair ordinary conditions,	3.
Good conditions,	4.
Very good conditions,	5.

The records and observations must be made as nearly as possible at the times indicated in the record-book. Railroad or "Standard" time is to be used, or if not, the standard used should be specified. The records are to be made in duplicate, the right-hand set being mailed on Wednesday and Saturday evenings in the envelopes provided for the purpose. The left-hand set is to be retained at the mill for use in case of accident to the other set, and for reference there.

Where the mill is situated on a canal or stream of water, the temperature of the water near its surface is to be taken at four P.M., and recorded as observation 15.

Observers will please note in the column of remarks any occurrences falling under their notice which, in their opinion, will throw any light upon the working of cotton as affected by the atmosphere.

It was not originally intended to take observations upon the *variations* of numbers, and it was only at the desire of several of the mill agents where the observations were taken that this was done. Comparatively few of the mills reported these and the variations of strength and elasticity according to the scale in the code, but gave actual results instead. Some of the mills were able to report upon number, strength, and elasticity but once per day. As a rule, the cotton did not change during the season.

In this code will be noticed directions to omit recording *relative* humidity, barometer, direction and velocity of wind. This direction was given; since it was found that the instruments necessary to take the last three of these observations would cost in the vicinity of a hundred dollars for each mill, and it was not known that the results obtained from them would be of sufficient value to justify so large an expenditure.

As the result of my study up to this time, I am convinced, that, for reliable results, the direction of those winds which affect the running of the work must be taken at such a station that they are not affected by surrounding buildings, trees, or even ranges of hills, which latter may, in some cases, be at a considerable distance from the mill. We have heard of certain valleys where there never existed winds of more than two directions, one directly up the valley, and the other in exactly the opposite direction. No matter in which direction the wind was blowing outside, the hills deflected it in such a way as to give it either one or the other of these directions in the valley itself.

These facts were realized to a certain extent at the outset, and it was decided to take these data from the United-States Signal Service stations in the section where the mill was situated, should it later seem probable that they were of sufficient importance to make it desirable. Some of the mills have reported some of these data, being already in possession of the necessary instruments. Observation 3, relative humidity, was to be calculated here from 1 and 2. For this purpose I have used the table used by the United-States Signal Service, and printed in the report of the Chief Signal Officer, 1881, and in

the "Instructions to observers of the Signal Service, U.S.A." As yet there is no exact experimental knowledge of the humidity of the air; this depends upon the weight per cubic foot of saturated steam at temperatures from 32° to 100° Fahr., a satisfactory determination of which has thus far not been accomplished.

As knowledge has increased, it has been proved, for various reasons, that the from time to time accepted humidity-tables were in error, and others have been prepared. It thus happens that there are several tables in print which do not agree with each other. I have not had time to critically examine the basis upon which this particular table was prepared, but have assumed that the United-States Signal Service have means of knowing that it is the best to be had. I have therefore used this table entirely, so that the work has all been done upon the same basis. In addition to the work done at the mills by persons connected with them, it was proposed to have an electrician visit one or more mills, and make measurements upon atmospheric electricity in the various rooms. Mr. A. C. White was selected to do this work, and his report is herewith submitted.

After a short examination of the work which had been done by various scientists upon those points which were obscure in this subject, he found that no exact electrical measurements could be made this season, since there was no instrument to be obtained in this country suitable for the work; and one ordered from Europe would probably arrive after dog-days were gone.

He has, however, as his report shows, made some qualitative experiments, to see if there was any encouragement to proceed further in that direction at a later time.

For this reason it was necessary to continue the work with the observation book if any thing was to be learned before this meeting; and, consequently, I took the books to those mills where the conditions of the work and situation had seemed to the committee to make it desirable to establish an observation station. In nearly all cases I found the authorities willing to furnish the instruments needed, and to do the necessary work, although several expressed the opinion that it was a waste of means and energy to do so. The instruments selected for the work were the dry and wet bulb thermometers made by Green, of New York, for the United-States Signal Service. These

were selected on account of the absolute necessity of having as good thermometers as we could get for this purpose.

It is, in fact, a very difficult thing to make and use an *accurate* thermometer; but from the results of these observations it is evident that these instruments are sufficiently good for our purposes in this investigation. Had there been errors of two or three degrees in many of them, a not uncommon error in so-called *fine* thermometers, the error introduced would have been enough to have destroyed the entire value of this work.

The observations begun with those of July 18 for the first mill to begin, and with those of Aug. 25 for the last, all but two beginning on or before Aug. 4. The work has been interrupted by shut-downs in some of the mills.

The earlier reports were closely examined, in a general way, by both Mr. White and myself, — he to see if he could see any indications that trouble was caused by electrical conditions, I to see if it seemed likely to be due to any other cause which was being reported. The reports were such that but little could be learned from them in this way; so I examined the most promising ones in a more thorough and systematic way, only to be disappointed, and get the impression that a large percentage of the observations would prove unreliable when we got enough of them together, so that an average might be obtained. At this time the thought occurred to me, that it was possible that there was some peculiar way in which cotton absorbed, and gave up water with the changes of humidity of the atmosphere, which changes might affect the running of the work, and the determination of which might throw some light upon the subject. For instance, when the air was in a certain definite condition as to humidity, we might find that a sample of cotton which had been freely exposed, contained six per cent of water; and when the air changed its condition to a more humid one, we might find that it contained some other percentage. Now, if the attraction of the cotton for water were exactly like that of the air, there would be the same relation between the humidity of the cotton and that of the air in both cases. On the other hand, if the attraction of the cotton for water were different from that of the air, we might find that the cotton would become either relatively very much drier or more humid than the air, when a change of humidity occurred in the atmosphere. If such were the case, it *might* be found that this action was the cause of the changes in the working of the cotton.

In view of these possibilities, I applied to your president for permission to employ a chemist to make some determinations of the amounts so absorbed and given up. Receiving permission to do this, I employed Mr. Gill, who is Professor Nichols' assistant, to do the work. Mr. Gill's report is given at the end of this paper. This may prove to be a subject worthy of further investigation. It was an entirely new subject, and, at about the time when sufficient had been learned to indicate the proper method of working, as much money had been expended upon it as I had applied for; and it was dropped for the time. The proper way of making these determinations seems to be to use a small room, as large, perhaps, as fifteen feet square and ten feet high, within which the work is to be done, and in which the temperature and humidity of the air may be easily controlled. In this room small samples of cotton are to be freely exposed in watch-glasses, and weighed from time to time on a chemical balance. The temperature and humidity are changed as occasion requires. In our case we were obliged to depend upon the natural variations of the atmosphere itself, and we were unfortunate in doing the work at a time when these did not occur with sufficient frequency to get observations covering the conditions which have been met in the mills this last summer. It will, however, be noted in the report, that we did get very decided indications that large variations, due to changes in the atmosphere, do occur in the amount of water carried by a given sample of cotton.

As a part of this work, two samples of River-Bottom cotton were freely exposed to the air for several days, being weighed from time to time. The weight varied .62 and .66 per cent respectively. As this cotton gave up 8.15 per cent of water when thoroughly dried, the variations in its humidity seemed to amount to 7.6 and 8.1 per cent of the actual amount contained at the beginning of the work. At this time the cotton had been freely exposed to the air, in the shape of sliver from the railway head, for several days; so that it was in the state in which it would be likely to be found in the mill under like atmospheric conditions. Two samples of a mixture of New Orleans, Memphis, Little Rock, and Texas cotton, which were treated in a similar manner, gave a variation in weight of .96 and .98 per cent. As this mixture gave up 7.85 per cent of moisture when thoroughly dried, the variations in its humidity

seemed to amount to 12.2 and 12.5 per cent of its actual amount at the beginning of the work.

The variation in weight of the water-vapor contained in a thousand cubic feet of the air while this variation was taking place in the weight of water carried by the cotton, amounted to fourteen per cent of that present at the beginning. This shows that with some cotton the humidity varied nearly as that of the air, while with other cotton the humidity varied only half as much as that of the air. The study of these measurements will throw some light upon the apparent variations in numbers in the mills. The gentleman who furnished this River-Bottom cotton informed me early in the summer that it worked as well in dog-days as at any time: his reports show the same thing. This smaller variation, in its actual humidity, may partially account for this fact.

By the time this work had been accomplished, a much larger number of reports had arrived, and I again returned to their study.

I used the graphical method, as being the one which most clearly shows to the eye the actual condition of affairs. I first plotted 12, the way in which the mill was running, for each mill, and will state that at this time, and until the completion of my study, the records and diagrams of each mill were kept by themselves. The reason for this was, that I did not get results from the various mills which, for a given moment of time, agreed well with each other. This is not surprising when we recollect the circumstances of the case.

Nearly every mill was using a different kind of cotton, was spinning a different number, was under different climatic conditions, and last, but not least by any means, had a different man for an observer, upon whose unverified judgment the one important fact from the mill was being reported. Instances of differences of the atmosphere were very common, and upon the completion of the diagrams, it was noticed that some mills only experienced certain changes — which were general — several hours after they were reported from other mills. By taking the mills separately, these several conditions were separated; and we might reasonably hope to discover the causes of the variations in the work, if they depended upon any of the facts reported, and if the observer noted the variations at the same rate, or upon the same scale, from day to day. This is a diffi-

cult thing to do, especially when a shut-down of from two to ten days intervenes between two observations, as was often the case.

The earliest reports seemed to show that the spinning ran worse as the temperature rose, and that, for a given temperature, the mill would be running at a certain definite rate; but it was but a short time before reports came in which showed either that this was not the case, or that we could not depend upon the accuracy of the reports. The "state of the weather," as reported, showed from the first that this was not the cause of the variation in the running of the work. The relative humidity was then examined critically, and it was evident that this was not the hidden cause of the trouble. I may say here, that one gentleman who has transmitted a very carefully observed series of readings, informed me at the outset that he had some months previously made a careful series of observations, and that temperature and relative humidity had apparently nothing to do with the running of the work. Upon examining the effect of the variations in the direction of the wind, no clew to the law governing the working of the cotton was found.

This was a rather discouraging state of affairs, and every hypothesis that had been advanced was considered again, to see if any light could be thrown upon the actual state of affairs. Upon looking over for a second time a series of calculations which I had made upon relative humidity, I thought that I noticed an apparent relation between the running of the spinning in one of the mills, selected because of its reports showing spinning running 1 and 5, as well as all intermediate rates, and a certain factor in these calculations. This factor was the *dew-point* at the times of the various observations, and is found as an intermediate step in finding the relative humidity when the Signal-service method of determining the latter is followed.

This point appeared to be an important one, and it led to a careful study of the known facts relating to humidity.

As this subject of humidity seems not to be understood very fully by most of the manufacturers with whom I have conversed, a brief statement of the actual facts may perhaps prove of interest, and lead to a better understanding of the latter part of this paper.

At any definite temperature, the atmosphere can absorb a

definite amount of water, which amount is different for different temperatures. This water exists in the form of an invisible vapor, and the greatest weight that can be absorbed in this state by a thousand cubic feet of the atmosphere, is the weight of a thousand cubic feet of saturated steam of the same temperature. When this weight is absorbed, the air is said to be saturated. Should a greater quantity of water be present in the atmosphere, this excess must exist in the state of liquid water, and not as a vapor.

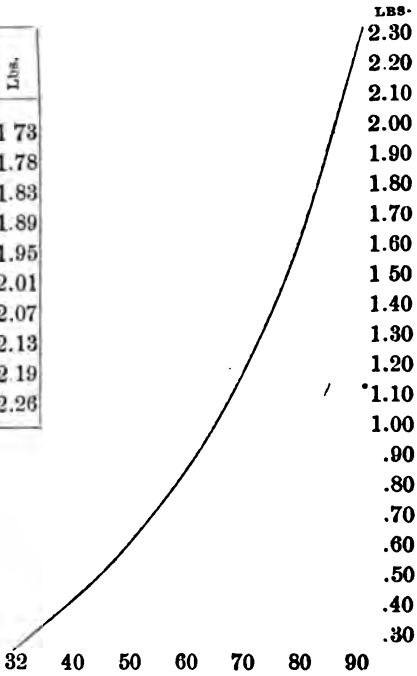
For a number of reasons connected with the relations of heat with the air, the vapor, the liquid water, and the solid objects in contact with them, it is but seldom that the outer atmosphere is to be found completely saturated in any considerable volume.

The water-vapor present is almost always less than the greatest possible amount, as stated above. If water be present, *and it is warm enough*, it will evaporate, and tend to bring the air into the saturated state. If we know how much water is contained in a thousand cubic feet of atmosphere at any given point and moment, we might, from a table of the weights of saturated steam, find how much water is necessary to completely saturate it at the temperature at which it is found. This actual amount, being usually smaller than the possible amount, can then be expressed as a percentage of the latter. This percentage is the *relative humidity* of the atmosphere under the given conditions.

As previously stated, the weight of a cubic foot of saturated steam at low temperature is not exactly known. Enough has, however, been learned from mathematical investigations, to permit the preparation of tables which cannot be very far from correct. I have on the board, one of these tables of the weight of saturated steam, and the graphical representation of the same. This table shows the weight in pounds of a thousand cubic feet of steam at temperatures from 32° Fahr. to 92° Fahr.

WEIGHT IN LBS. OF 1,000 CUBIC FEET SATURATED STEAM AT TEMPERATURES 32° FAHR. TO 92° FAHR.

Temp.	Lbs.	Temp.	Lbs.	Temp.	Lbs.	Temp.	Lbs.
32	.30	49	.56	66	1.00	83	1 73
33	.30	50	.58	67	1.03	84	1.78
34	.31	51	.60	68	1.07	85	1.83
35	.32	52	.62	69	1.11	86	1.89
36	.33	53	.65	70	1.15	87	1.95
37	.34	54	.67	71	1.19	88	2.01
38	.36	55	.69	72	1.23	89	2.07
39	.38	56	.71	73	1.27	90	2.13
40	.40	57	.73	74	1.31	91	2 19
41	.42	58	.76	75	1.35	92	2.26
42	.43	59	.79	76	1.39		
43	.45	60	.82	77	1.43		
44	.47	61	.85	78	1.48		
45	.49	62	.88	79	1.53		
46	.50	63	.91	80	1.58		
47	.52	64	.94	81	1.63		
48	.54	65	.97	82	1.68		



From this table we can readily find the amount of water-vapor which will just saturate a thousand cubic feet of the atmosphere at any temperature.

The method of finding the actual amount present, and from this the relative humidity, can only be understood when it is known what is usually meant by the dew-point.

I have here two glasses, one containing ice-water, and one containing water at about the temperature of the air: you will notice that the cooler of these glasses is covered on the outside with water, while the other is not. Now, by taking about forty such glasses, and having them filled with water of different temperatures, and having them arranged on this table in such a way, that, on this end of the table, there would be this glass containing water at 32° Fahr., while at the other end we should have this one at 75° Fahr., and so that the water in each glass should be just one degree warmer than that of its left-hand neighbor, we should find that every glass up to a certain point in the series would be wet on the outside, while all the others would be dry.

The temperature at which the glasses begin to become wet is called the *dew-point.* This is simply the temperature at which a definite volume of the existing atmosphere would become saturated if it were taken and cooled by itself. It is evident, that, knowing the dew-point, we can take from the table the weight of the water-vapor in a thousand cubic feet of air as it is; that is, the weight of a thousand cubic feet of saturated steam of the temperature of the dew-point. We can then take the larger amount which would exist in the air if the dew-point were at the air temperature, and from these two quantities obtain the relative humidity as previously indicated.

It may be of interest here to note that the *relative* humidity gives us no indication whatever of the actual condition of the air as to humidity; and the only thing we can say with certainty about it is, that, as the relative humidity *at a given air temperature* falls or rises, the air has a greater or less tendency to absorb moisture. It is quite certain that the drying of cloth, when maintained at 70° Fahr. in an atmosphere of 50 relative humidity, takes place slower than it does when maintained at 100° Fahr. in an atmosphere of 70 relative humidity. It is hard to see why the prevalent idea, that relative humidity should be an important element affecting the running of mills, has gained such ground, when the fact is, that 50 relative humidity means that there are .5 pound water in a thousand cubic feet of atmosphere at 66° Fahr., one pound at 88° Fahr., and two pounds at 112° Fahr., — all temperatures within the range of our reports. It is only when the temperature is fixed at one point that it gives any valuable information. It is possible that at mills where the rooms are kept at an almost perfectly uniform temperature, differences in relative humidity have been observed, and some connection between these and the way the work was running. In this case the relative humidities would be proportional to the weight of water-vapor present; and effects might be attributed to the former which were really due to the latter, thus misleading those who were informed of the observations.

Returning to the consideration of the reports from the mills, I found, upon plotting the dew-points to date of Mill No. 7, that the dew-point frequently rose as the spinning went worse.

Thinking that this must mean that the spinning run worse as the actual amount of water in the air increased, I plotted the actual amount of water present in a thousand cubic feet of

air in such a way as to show whether this were the case or not. The result was very striking, and is shown on the board.

This curve, S, represents the way the spinning was running during the whole period of the observations. This second curve, V, represents the amount of water present in a thousand cubic feet of atmosphere during the same period. The third curve, D, is the curve of dew-points.

The fine vertical lines represent the times of the observations. An investigation of the observations recorded in this second curve, by another method, shows the results given in the following table.

MILL No. 7.

Weight of Water in 1,000 cu. ft. Atmosphere, lbs.	Rate at which Spinning is Running.
.93 or less	5.
.93–1.04	4.
1.04–1.15	3.
1.15–1.25	2.
1.25 and above.	1.

This may also be expressed in a table where the dew-points take the place of the corresponding weights of water-vapor: such a table is given below.

MILL No. 7.

Dew-Points.	Spinning.
64 or less	5.
64–67	4.
67–70	3.
70–73	2.
73 or above.	1.

It is to be noted that the above tables give the most probable values of these varying relations, as shown by the actual reports from this mill. If observations were made covering a series of years, these figures might be changed slightly. As an actual fact, one hundred and five observations were made in this mill; and only four of these give an error of three, when calculated

by the above rule; and we have evidence that some of these were either mistakes of the observer, or due to the fact that the instruments recorded a change before the work felt it; since, at the corresponding times in other mills, the effect of certain sudden changes was seen in the work, and reported, while here it was not. Besides these, three observations give an error of two when calculated in this way; while all the rest, ninety-eight in number, give an error of one or nothing, much the larger number giving no error. A little consideration will show that an error of *one* might be expected in *any* single report. Let us suppose one man to be present in a spinning-room, and to be in possession of absolute knowledge which would enable him to correctly report the way the spinning was running upon a scale of one hundred. Now, if the way the spinning was running should be expressed by this man by any number from seventy-seven to eighty-three, it is evident that an ordinary man could not tell whether to report it *four* or *five*, especially if this exact way of running had not before occurred for several days, as was, in fact, frequently the case. It is also evident, that, if the mill were actually running in such a way that it ought to be expressed by seventy-nine, a change in conditions might occur which would lower this figure to sixty-one, and the observer might notice this. He would probably mark the spinning either five in the first case and four in the second, or four in the first case and three in the second.

In fact, they should both be marked four; although a very much less change in the running of the mill would cause a difference of one in the report, if it came at a different point of the scale. So far as we can judge from these reports, we can say with a great deal of confidence that there *is* this probable error of one in the report of the spinning at any given time, and this does not at all imply any lack of accuracy in the observer.

We can also say with confidence, that, in the reports of many of the mills, there is not a *greater* probable error than one, and that this is a much more reliable method of taking observations upon such a complex thing as the running of a whole large spinning-room, than would at first sight appear to be possible.

I have plotted the dew-points, in connection with the way the spinning was running, for all the mills.

Observing that Mill No. 3 was never reporting the spinning

as one, and very seldom as two, I examined their reports in the same manner as those of No. 7, and obtained the similar table given below.

MILL No. 3.

Dew-Point.	Spinning.
65 and below	5.
65-70	4.
70-74	3.

We have here one hundred and eighteen observations, and only two of these make an error of more than one when calculated by the above rule! It will be noticed that this rule is slightly different from that obtained from Mill No. 7.

Following the same method, I have examined the reports of all the mills which have sent them, fourteen in number, and found, in the case of every mill but two, a table similar to the above. In no case did any of these twelve remaining mills give as many as twenty-five per cent of their observations disagreeing with the table, allowing a probable error of one in the observations as previously explained.

Taking the average of all the mills but one, and giving the results of each mill equal weight, I arrive at the following table of how the average cotton-mill will run.

Dew-Point.	Spinning.
Below 68	5.
68.0-71 5	4.
71.5-74.5	3.
74.5-77.5	2.
Above 77.5	1.

From an examination of the various tables separately, it is seen that many of them do not agree very well with this average table; and any mill had probably better rather depend upon its own table than upon this average one. It seems likely to be the fact, that the various kinds of cotton act differently when exposed to identical variations of temperature and humidity.

These tables from the various mills are here furnished for the information of the members of this Association. They will not be entirely reliable, being subject to all the imperfections due to this method of investigation.

No. of Mill.	Dew-Points.	Way Spinning was Reported.	Remarks.
1.	Below 69.5 69.5–76 76.0–82	5 4 3	Observations agree well with this rule.
2.	Below 68.5 68.5–71.0 71.0–73.5 73.5–76.5	5 4 3 2	Observations agree fairly well with this rule.
3.	Below 65 65–70 70–74	5 4 3	Observations agree almost absolutely with this rule.
4.	Below 70.5 70.5–73.5 73.5–76.5 76.5–79.5	5 4 3 2	Observations agree very well with this rule.
4a.	Below 73 5 73.5–76.0 76.0–78 5 78 5–80.5	5 4 3 2	Observations do not agree well with this rule. Plotted curve agrees with deduced theory till Sept. 4, when it seems to be at random.

No. of Mill.	Dew-Points.	Way Spinning was Reported.	Remarks.
5.	Below 71 Above 71	5 4	Curve doubtful, but gives a general agreement with deduced theory.
6.	Below 66 66–74	4 3	Observations agree very well with this rule. Curve agrees very well.
7.	Below 64 64–67 67–70 70–73 Above 73	5 4 3 2 1	Observations agree very well with this rule. Curve agrees excellently with deduced theory.
8.			Curve agrees with deduced theory in a general way. Increase of weight of vapor in atmosphere causes worse spinning in about half the cases, with the other half the reverse is the case. No rule can be deduced about the dew-point.

No. of Mill.	Dew-Points.	Way Spinning was Reported.	Remarks.
9.	Below 72 72–76 Above 76	3 2 1	Observations agree well with this rule. Curve agrees well with deduced theory.
10.	Below 69 69–73 73–77 77–81	5 4 3 2	Observations agree well with this rule. Curve agrees well with deduced theory.
11.		All but one observation, 5	River-Bottom Cotton. Atomizers were used at one time for a few hours when the dew-point was above 75. They were stopped before the weather changed.
12.	Below 69.5 69.5–72.5 72.5–75.5	5 4 3	Observations agree well with this rule. Curve agrees well with deduced theory.
15.	Below 68 Above 68	4 2	Curve agrees well with deduced theory.

There is no question whatever that a great majority of these observations show that the running of the spinning depends upon the weight of water present in a definite volume of the atmosphere, and that, after a definite quantity is reached, increasing that quantity will make the spinning run worse until it runs as badly as it ever does in dog-days.

Upon learning that this was the case, I obtained a number of data from the observing mills, which will have a bearing upon the question of overcoming the difficulty by artificial means. These data, with some others, are given in the following table: —

No. of Mill.	Height of floor of Spinning-room from ground.	Number Spindles.	Kind of Spindles.	Kind of Ring.	Speed of Spindles.	Volume in cubic foot of room.
1	43′ 2½″	14,016	Birkenhead, 2,560 S. M. I. Co., 11,456	Draper's 1⅝″ double adj.	6,800	203,400
2	48′	Ring-frames 23,296 14 spoolers, 1,400	Sawyer's Improved.	Whitin's adj.	6,995 Ring-frame	431,648
3	31′	10,080 Ring 6,528 Mule	Sawyer.	1¼″ double adj.	7,500	224,796
4	38′	20,160	Sawyer.	(Single) L. M. S.	7,000	218,132
4a	36′	13,696	Sawyer.	(Single) L. M. S.	7,000	97,500
5	32′ (about)	14,400	Rabbeth.	Whitin's,	7,200	261,000 abt.
6	8′	11,520	Sherman.	Double adj.	8,500	214,200
7	32′ 9″	24,128	Sawyer, fine, modified	1⅝″ double adj.	7,100	322,366
8	45′	16,512	Pearl.	1⅝″ double adj.	6,400	326,032
9	63′ 93′	10,816	Old Sawyer.	Draper's double adjustable.	6,000	152,405
10	58′ 10″	22,528	2,240 Pearl. 1,280 Sawyer. 19,008 Birkenhead.	1½″ double adjustable,	7,200	326,706⅔
11	–	–	–	–	–	–
12	32′	4,560	Rabbeth.	Draper's double.	6,000	76,800
15	60′	30,600	Sawyer, modified.	⅓ double eccentric ⅔ common.	6,500	564,500

No. of Mill.	Area of floor in sq. feet.	Square feet of Windows.	Windows ever open at bottom?	At top?	Sizes of Ventilators if any.	Number of Same.	Estimated Horse-power used in Room.	No. Operatives Employed in room.	Number of Yarn.	Grade of Cotton.
1	13,790	1,152	No.	Yes.	None.	–	161.	60	28½	–
2	30,832	2,160	No.	Yes.	None.	–	242.64	115	25	Texas, good middling.
3	17,292	1,600	No.	Yes.	–	–	94.	36	60 & 70	Vicksburg, Mississippi.
4	16,567	1,620	Yes.	Yes.	None.	–	265.	58	22 & 19	Good middling.
4a	10,000	863	Yes.	Yes.	292,500 cub ft. per hour, both.	2	240.	31	22	Good middling.
5	17,400	2,318	No.	Yes.	30″	3	150.	34	22	Texas, Memphis, and St. Louis mixed.
6	13,850	1,727	No.	Open in warm weather.	None.	–	120.	45	–	–
7	23,879	2,935	Seldom.	Used for ventilation.	–	–	221.	57	29	New Orleans, Mem., Little Rock, Texas.
8	23,288	2,248 frames	No.	Yes.	–	–	160.	50	22	Upland.
9	10,755	1,163½	No.	Every other one in hot weather.	None.	–	84.	33	19½	S. L. M., N. Y. Spot, Memphis, Texas.
10	20,419	1,522.64	No.	Yes.	5 (2′ × 2′) 10 (2′ × 3′)	5 10	206. Ind.	60	28	–
11	–	–	–	–	–	–	–	–	28	River-bottom.
12	5,120	700	No.	Yes.	None.	–	45.	9	60 & 80	Florida Sea-Island.
15	40,320	3,584	Yes.	Yes.	None.	–	350.	190	28	–

I think a little consideration will now make it clear why a north-east wind in Fall River will be likely to make the spinning run better than one from the south-east. Physical geographers tell us that there is a peculiar condition of the sea, as to temperature, north and south of Cape Cod. The water north of the cape is much colder than the water south of it. This is so well marked, that many forms of marine life, which seem to depend for their existence upon the temperature of the sea, are never found north of the cape, while they abound in the sea south of it. Others, preferring the colder water, are found north of the cape, but never south of it. The north-east winds of Fall River are those which have blown over this cold water at the north of the cape, and, consequently, have become cooled and robbed of much of their moisture; in a similar way, high ranges of mountains rob the air of much of its moisture as it passes over their cold summits. On the other hand, the south-east winds at Fall River are those which have come over the warmer sea, and are warmed and heavily laden with moisture; a few degrees difference in temperature making a great difference in the capacity of the air to absorb moisture. It would thus seem to be a fact, that the situation of the mill as to its geographical surroundings may become an important factor in its successful working.

I have made a short and approximate calculation upon the necessary means to be taken for removing the surplus moisture in a room of the size of that where the reports were made, in Mill No. 7. There are 322,000 cubic feet in this room, and there are 57 operatives employed in it. For health, these need to have the air in the room completely changed in ten hours. This allows very nearly ten cubic feet of air per minute for each operative. In this mill, between July 21 and Aug. 30, 36 working days, it appears that the dew-point averaged nearly 72. This means that there were 1.23 pounds of water-vapor in 1,000 cubic feet of atmosphere. If the dew-point be depressed to 64, the point apparently necessary for the best results in spinning, we should then have present .94 pound water-vapor in 1,000 cubic feet of atmosphere. The difference, .29 pound, is what must be removed for every 1,000 cubic feet of the room. If the dew-point of the air is found at 72 in the morning, and remains at 72 all day, we should need to remove twice this amount daily, or .58 pound. This amounts to about 42 pounds

daily for a room of this size and number of operatives. The removal can probably be most cheaply accomplished by means of ice or very cold water.

It will take about five pounds of ice to condense one pound of this vapor. We therefore should need 210 pounds of ice per day in this room for condensing this amount. Practically we should probably use a considerably larger amount; but there seems little doubt, that, with proper means of using it, 300 pounds of ice per day, or say a ton per week, would have kept this room in the requisite condition of humidity this season, if there were no other conditions to be considered than the size of the room and the number of operatives. Unfortunately there is another factor to be considered, the magnitude of which is so very great that this humidity question may almost be neglected in comparison with it. This is the amount of heat generated by the friction of the machinery. We use in this room 220 horse-power, and this power re-appears in the room as heat. The amount of this heat generated in ten hours is equal to what we should be able to absorb by about 28,000 pounds of ice, melted and raised to the air temperature. This, then, would amount to 84 tons per week expended in keeping the room at the temperature of the outer air. Under the present conditions of working, this immense amount of heat generated in a spinning-room is washed away by the large quantities of air admitted to the room, aided by the heat transfer through walls and closed windows, caused by the fact that the temperature within the room is usually higher than that of the outer air. Besides these two factors, the action of the sun upon any building would increase the amount of ice necessary. The probability is, that at least 100 tons of ice per week would be necessary to keep this room at the desired humidity and at the temperature of the outer air. There are 24,128 spindles in this room.

The atmosphere of the spinning-room might be kept sufficiently dry, and in a fair working condition, by washing away this large amount of heat by air, drying the latter by the use of ice before admitting it into the room. An approximate calculation shows that the consumption of ice by this method would, in this room, amount to 18.5 tons per day, allowing the temperature within the room to rise 15 degrees above that of the outer air.

As a matter of interest I may quote the statement, from a

recent article in the "American Machinist," that, with a certain ammonia ice-machine there described, an equivalent cooling-power to a ton of ice can be obtained at an expense of from 15 to 30 cents, according to the price of coal. I have seen this machine in operation; and, while it cannot be recommended for cotton mills on account of the use of ammonia, it does very effectually cool rooms which compare well in size with the room we have been considering, and to a very low temperature, so that there is no question as to the possibility of cooling a room sufficiently, and making it sufficiently dry. There is the question of whether or not it will pay to do so. Other ice-machines than this particular one are available.

The following table, obtained from Sergeant Cole of the United-States Signal Service, shows the average monthly temperatures, dew-points, and relative humidities at the Boston Station for the months of July, August, and September, for the years 1881, 1882, 1883, and 1884.

	July.			August.			September.		
	Temp.	Dew-Pt.	Rel. H'y.	Temp.	Dew-Pt.	Rel. H'y.	Temp.	Dew-Pt.	Rel. H'y.
1881	68.5	58.8	73 1	69.5	60.0	74.0	65.7	58.2	78.8
1882	71.7	57.7	65.1	69.7	56.7	66.0	62.7	55.0	78.0
1883	71.3	60.7	71.7	67.6	55.1	66.8	59.3	49.9	73.8
1884	68.0	59.6	76.4	68.3	62.8	84.5	65.8	55.4	71.2

This table will permit a comparison between the weather of this year and that of previous years, and also allow a judgment to be formed as to whether this has been a favorable season for this investigation. My own impression is, that it has been, on account of the numerous changes in the atmospheric conditions, a very favorable season for the work, as it has been possible to get an unusually large number of independent observations at times well separated from each other.

In conclusion, I must thank the Board of Government for their valuable advice and assistance in carrying on this investigation; also those gentlemen who have been to the expense and trouble of transmitting these reports. I am also exceedingly grateful to the observers who have been generally so careful in making out their reports, and to whose careful judgment we really owe every thing of value which may be in this paper.

DETERMINATION OF THE AMOUNT OF MOISTURE IN COTTON, AND OF THE AMOUNT RE-ABSORBED.

BY AUGUSTUS H. GILL, S.B.

THE object of this investigation was the determination of the amounts of moisture absorbed by dry cotton, under varying conditions of temperature and humidity.

It was at first proposed to test two specimens of cotton (Sea Island and mixed upland), at temperatures between 60° and 100° Fahr., and relative humidities from thirty to ninety; but this would necessitate an expenditure for apparatus, etc., which would hardly be judicious, unless some preliminary work, like this described in the present paper, had been done.

The work was conducted in the following manner: about four grams of cotton ("drawing") were accurately weighed out in a wide-mouthed, glass-stoppered bottle. This was arranged so as to allow a current of dry air, dried by passing over pieces of pumice soaked in sulphuric acid, to be drawn through it at the rate of one to two bubbles per second. The bottle was immersed in boiling water, and kept there for half an hour; it was then allowed to cool, requiring about half an hour, and accurately weighed: this process was repeated until weights agreeing within two milligrams were obtained.

The current of air was produced by a Richards aspirator, and the vacuum in the bottle amounted to an inch of mercury.

This cotton was then divided into two samples, spread out in watch-glasses, covered with accurately fitting covers, and weighed; it was then uncovered, and exposed to the air; after exposure, it was at first weighed every twenty minutes, and later every hour.

The cotton was always weighed between accurately fitting watch-glasses, so that, during the process of weighing, it could neither absorb nor lose moisture. The watch-glasses themselves, under different temperatures and humidities, would condense variable amounts of moisture upon their surfaces, and consequently change in weight. To eliminate this error, a set of empty watch-glasses was subjected to the same conditions as the others; and it was found that the change in weight was so small as not to impair the accuracy of the results.

For exposure, instead of using watch-glasses, it was proposed

to draw a current of moist air through the cotton placed in bottles. This method is more expeditious; but for temperatures and humidities other than those of the room, it has the objection that these cannot be easily measured. Another objection is, that it does not conform so nearly to the conditions in the mills.

For sample No. 1, one-half was exposed in watch-glasses, the remainder in a bottle. With this sample the work was not carried on with the accuracy of that of those following, as an approximate idea was desired of the length of time required for the work, and a test of the relative values of the watch-glass and bottle methods of exposure.

The figures will be found in reports of samples I.–V. The percentages, at the bottom of reports I., II., and IV., are both calculated with dry cotton as a basis, that they may be directly comparable. All other percentages, unless stated to the contrary, are calculated with cotton as it was received as a basis.

Of course, from so limited a number of determinations, no conclusion of absolute accuracy can be drawn. The cotton tested contained about eight per cent of moisture; the amount again absorbed was about six per cent, and three-fourths of this amount was absorbed in an exposure of half an hour.

SAMPLE No. 1. — UPLAND COTTON.

AUG. 5, 1884.

Cotton + bottle = 272.0950
bottle = 268.1287
Cotton taken = 3.9663 grams.

	Weight.	Loss.	t'.	t.	h.
Cotton + bottle =	272.095				
" "	271.795	0.300	72°	76°F.	82%
" "	271.777	0.018			
" "	271.7665	0.0105			
		0.3285 total loss.			

$$\text{Percentage of water} = \frac{0\ 3285}{3.9663} = 8.28\%, \text{ or, if dry cotton}$$

$$\text{be regarded as the basis} = \frac{0.3285}{3.9663 - 0.3285} = 9.04\%.$$

EXPOSURE OF SAMPLE No. 1.

Cotton + watch-glass = 55.148 watch-glass = 53.290 Cotton taken = 1.858			Cotton + bottle = 176.0825 bottle = 174.2590 Cotton taken = 1.8235				
Time. P.M.	Weight (grams).	Gain or Loss.	Time, P.M.	Weight (grams).	Gain or Loss.	Temperatures.	h. Humidity.
						t t.	
2.06	55.148	-	2.12	176.0825	-	72° 76° F.	82%
2.25	55.231	0.083	2.33	176.0890	0.0065	" "	"
2.50	55.2535	0.0225	3.00	176.1275	0.0385	" "	"
3.10	55.2618	0.0123	3.19	176.1425	0.0150	" "	"
3.55	55.2710	0.0092	3.35	176.1450	0.0025	72.5 76.5	"
4.15	55.2725	0.0015	3.58	176.1550	0.0100	73 77	"
4.35	55.2725	0.0000	4.20	176.1730	0.0180	" "	"
			4.40	176.1890	0.0160	72 "	76
			5.05	176.1990	0.0100	" "	"
Aug. 6, A.M.			A.M.				
8.15	55.2775	0.0050	8.25	176.2142	0.0152	71 75	82
9.25	55.2740	0.0035	9.20	176.2150	0.0008	71.5 76	79
Total gain = 55.2775 − 55.148 = 0.1295, or $\frac{0.1295}{1.858} = 6.97\%$. Dried out, 9.04%. Re-absorbed, 6.97%.			Total gain = 176.2150 − 176.0825 = 0.1325, or $\frac{0.1325}{1.8235} = 7.26\%$. Dried out, 9.04%. Re-absorbed, 7.26%.				

SAMPLE No. 2. — River-Bottom Cotton.

Aug. 7, 1884.

DRYING OF SAMPLE.

Cotton + bottle = 265.0620
bottle = 261 7106
Cotton taken = 3.3514 grams.

Time.		Weight.	Loss.	t'.	Grams. t.	D.P.	h.
8.18	Cotton + bottle =	264 9083	0 1537	73	78°	70	76.5
10 40	" "	264.8040	0.1043	71	75	69	82
11 42	" "	264.7815	0 0225	71.5	76	69	79
3 26	" "	264 7845	− 0 0030		"		"
4.45	" "	264 7870	− 0.0025		"		"

Loss = 265.062 − 264 7870 = 0.2732 total loss.

Percentage of water = $\frac{0\ 2732}{3.3514}$ = 8 15%, or, if dry cotton be regarded as the basis = 8.87%.

EXPOSURE OF SAMPLE No. 2 DRY.

Cotton + watch-glass = 54.8605 watch-glass = 53.2875 Cotton taken = 1.5730			Cotton + watch-glass = 71.3995 watch-glass = 69.8340 Cotton taken = 1.5653					
Aug. 8. Time.	Weight (grams).	Gain or Loss.	Time.	Weight (grams).	Gain or Loss.	Temperatures.	D.P.	h. Humidity.
						t'. t.		
2.40	54.8605	–	2.45	71.3995	–	–		
3.27	54.9345	0.0740	3.30	71.4660	0.0665	73° 79° F.	70	74%
4.25	54.9397	0.0052	4.30	71.4718	0.0058	73 "	"	"
Aug. 9, A.M.			Aug. 9.					
8.25	54.9393	–0.0004	8.32	71.4713	–0.0005	70° 75°	67	76%
P.M. 1.50	54.9357	–0.0036	1.58	71.4688	–0.0025	70 77	66	"
Aug. 11, A.M.			Aug. 11.					
8.40	54.9460	0.0103	9.00	71.4785	0.0103	66° 71°	63	76%
Total gain = 54.9460 – 54.8605 = .0855, or $\frac{0.0855}{1.5730} = 5.43\%$. Dried out, 8.87%. Re-absorbed, 5.43%.			Total gain = 71.4785 – 71.3995 = 0.0790, or $\frac{0.0790}{1.5655} = 5.05\%$. Dried out, 8.87%. Re-absorbed, 5.05%.					

SAMPLE No. 2 — *Continued.*

Aug. 8.

EXPOSURE OF SAMPLE No. 2 UNDRIED.

Cotton + watch-glass = 78.4695 watch-glass = 77.2105 Cotton taken = 1.2580			Cotton + watch-glass = 76.6580 watch-glass = 75.5242 Cotton taken = 1.1338					
Time.	Weight (grams).	Gain or Loss.	Time.	Weight (grams).	Gain or Loss.	Temperatures.	D.P.	h. Humidity.
						t'. t.		
3.05	78.4695	–	3.15	76.6580	–	–	70	74%
3.40	78.4730	0.0035	3.45	76.6581	0.0001	73° 79°	70	"
4.35	78.4738	0.0008	4.40	76.6584	0.0003	73 "	70	"
Aug. 9, A.M.			Aug. 9, A.M.					
8.36	78.4700	–0.0038	8.40	76.6545	–0.0039	70° 75°	67	76%
P.M. 2.04	78.4667	–0.0033	P.M. 2.15	76.6510	–0.0035	70 77	66	"
Aug. 11, A.M.			Aug. 11, A.M.					
9.05	78.4745	0.0078	9.10	76.6585	0.0075	66° 71°	63	76%

SAMPLE No. 2 DRIED IN VACUO OVER SULPHURIC ACID.

Cotton + watch-glass = 74.5895
watch-glass = 72.2045
Cotton taken = 2.3850 grams.

Time.	Weight (grams).	Gain or loss.
Aug. 7.		
4.55	74.5895	–
Aug. 8.		
9.25	74.4600	0.1295
10.40	74.4250	0.0350
4.45	74.4320	0.0070
Aug. 9.		
9.30	74.4575	0.0255
3.06	74.4490	0.0085
Aug. 11.		
10.00	74.4410	0.0080

Total loss = 0.1645 grams, or 6.89%.

SAMPLE No. 3.—Mixture of New Orleans, Memphis, Little Rock, and Texas Cotton.

DRYING OF SAMPLE.

Cotton + bottle = 272.2740
bottle = 268.1280
Cotton taken = 4.1460

	Time.			Weight.	Loss.	t'.	t.	D.P.	h.
Aug. 6,	4.57	Cotton + bottle =		271.984	0.2900	73	78°	70	76.5%
" 7.	8.10	"	"	271.9875	– 0.0035	71	75	69	82
" 7.	9.48	"	"	271.9448	0.0427	71.5	76	69	79
" 7.	11.35	"	"	271.9492	– 0.0044	"	"	"	"
" 7.	2.45	"	"	271.9485	– 0.0007	"	"	"	"

Loss = 272.274 – 271.9485 = 0.3255, or $\frac{0.3255}{4.1460} = 7.85\%$,

or if dry cotton be regarded as the basis = 9.21%.

Aug. 8.

EXPOSURE OF SAMPLE No. 3 DRY.

Cotton + watch-glass = 98.4661 watch-glass = 96.4655 Cotton taken = 2.0005			Cotton + watch-glass = 74.8735 watch-glass = 72.9910 Cotton taken = 1.8825						
Time. A.M.	Weight (grams).	Gain or Loss.	Time. A.M.	Weight (grams).	Gain or Loss.	Temperatures.		D.P.	h. Humidity.
						t'.	t.		
9.25	98.466	–	9.15	74.8735	–	70°	74°	68	82%
9.45	98.5435	0.0775	9.40	74.9495	0.0760	"	"	"	"
10.10	98.5700	0.0265	10.15	74.9732	0.0243	"	"	"	"
10.36	98.5800	0.0100	10.42	74.9785	0.0053	"	75	67	76
11.13	98.5848	0.0048	11.20	74.9818	0.0033	"	"	"	"
P.M.			P.M.						
1.40	98.5876	0.0026	1.47	74.9837	0.0019	71	76	68	"
4.06	98.5835	–0.0041	4.10	74.9810	–0.0027	73	79	70	74
Aug. 9.			Aug. 9.						
9.00	98.5780	–0.0055	9.10	74.9745	–0.0065	70°	75°	67	76%
2.17	98.5715	–0.0065	2.25	74.9695	–0.0050	"	77	66	69
Aug. 11.			Aug. 11.						
9.15	98.5845	0.0130	9.20	74.9805	0.0110	66°	71°	63	76%

Total gain = 98.5876 − 98.466 = 0.1216, or $\frac{0.1216}{2.0005} = 6.08\%$.
Dried out, 9.21%.
Re-absorbed, 6.08%.

Total gain = 74.9837 − 74.8735 = 0.1102, or $\frac{0.1102}{1.8825} = 5.98\%$.
Dried out, 9.21%.
Re-absorbed, 5.98%.

SAMPLE No. 3 — *Continued.*

Aug. 8. EXPOSURE OF SAMPLE No. 3 UNDRIED.

Cotton + watch-glass = 85.6670 watch-glass = 84.0005 Cotton taken = 1.6665			Cotton + watch-glass = 72.8092 watch-glass = 71.2120 Cotton taken = 1.5972						
Time.	Weight (grams).	Gain or Loss.	Time.	Weight (grams).	Gain or Loss.	Temperatures.		D.P.	h. Humidity.
						t'.	t.		
9.02	85.6670	–	8.50	72.8092	–	70°	74°	68	82%
9.55	85.6677	0.0007	10.00	72.8103	0.0011	"	"	"	"
10.23	85.6680	0.0003	10.26	72.8089	–0.0014	"	"	"	"
11.24	85.6674	–0.0006	11.30	72.8088	–0.0001	70	75	67	76
P.M.			P.M.						
1.55	85.6669	–0.0005	2.00	72.8082	–0.0006	71	76	68	"
4.15	85.6650	–0.0019	4.20	72.8052	–0.0030	73	79	70	74
Aug. 9, A.M.			Aug. 9, A.M.						
9.15	85.6562	–0.0088	9.20	72.7980	–0.0072	70°	75°	67	76%
P.M.			P.M.						
2.30	85.6520	–0.0042	2.35	72.7946	–0.0034	70°	77°	66	69
Aug. 11, A.M.			Aug. 11, A.M.						
9.25	85.6615	0.0095.	9.40	72.8030	0.0084	66°	71°	63	76%

SAMPLES No. 4 I AND No. 4 II. — Sea Island.

Aug. 11. DRYING OF SAMPLE.

4 I.

Cotton + bottle = 265.3944
bottle = 261.7080
Cotton taken = 3.6864

	Weight.	Loss.
Cotton + bottle =	265.3944	–
" "	265.2893	0.1051
" "	265.2090	0.0803
" "	265.1740	0.0350
loss =		0.2204

Percentage of water = $\frac{0.2204}{3.6864}$, or 5.98%.

4 II.

Cotton + bottle = 272.2615
bottle = 268.126
Cotton taken = 4.1355

	Weight.	Loss.
Cotton + bottle =	272.2615	–
" "	271.9980	0.2635
" "	271.9747	0.0233
" "	271.9765	0.0018
loss =		0.2868

Percentage of water = $\frac{0.2868}{4.1355}$, or 6.93%.

EFFECT OF ATMOSPHERIC ELECTRICITY UPON THE SPINNING OF COTTON.

BY ANTHONY C. WHITE, S.B.

THE subject of atmospheric electricity is one that has been but little investigated. I have, however, been able to obtain some reliable data, which will give us some idea of the weight we should attribute to it in cotton-spinning.

Quetelet found that at Brussels the daily indications of potential (during fine weather) showed two maxima occurring in summer at eight A.M. and nine P.M., and in winter at ten A.M. and six P.M. respectively; and two minima which in summer were at the hours of three P.M. and about midnight.

For the different months of the year 1846 he made the following observations: —

January	562	July	33
February	256	August	57
March	95	September	62
April	94	October	98
May	49	November	274
June	39	December	799

Observations made by Professor Stewart at Kew show a maximum at eight A.M. in summer and ten A.M. in winter, and a minimum at ten P.M. in summer and seven P.M. in winter. In Paris M. Mascart finds but one maximum, just before midnight. At sunrise the electricity diminishes until about three P.M., when it has reached a minimum, whence it rises till nightfall.

The potential is found to increase the higher we ascend. Sir William Thompson found the potential of the island of Arran to increase from twenty-three to forty-six volts for the rise of one foot of level; but the difference was sometimes eight or ten times as much for the same difference of level, and changed rapidly as the east wind blew masses of clouds charged with more or less electricity across the sky. Joule and Thompson found the rise of potential to be equal to forty volts per foot at Aberdeen. Some observations made by Sir William Thompson at Invercloy in October of 1859, during the four days in which the measurements were made, showed a variation from nine to a hundred and twenty-six volts per foot. During fine weather negative electrification of the air is very rare; but during rain

it is more often negative than positive, and exhibits great fluctuations changing from negative to positive, and back, several times in half an hour.

The best theory of atmospheric electricity is this: the earth acts as a negatively charged body, the upper regions of the atmosphere as a positively charged body, and the lower strata as a dielectric; the whole forming a large Leyden jar.

The potential of the atmosphere within a room where there was no chance for admission of air from without would be the same as that of the earth, — or zero. If the windows were opened, the potential would be a mean between that of the earth and the outside air, depending upon the rapidity of the circulation and the facilities for discharge which the room offered.

TESTS MADE IN THE SPINNING-ROOM OF THE MERRIMAC MILL.

I have tested a spinning-frame with a Peltier electroscope, and found no portion of the frame electrified. Some bobbins of cotton-roving, resting upon the frame, were found to be electrified. Tested the atmosphere about the belts, using a water dropper with the Peltier electroscope, and a needle with the gold-leaf electroscope to bring the instruments to the same potential as the air at the point to be tested. The atmosphere for some distance about the belts was highly electrified, and the electrification increased from the walls of the room to the centre. I tried the effect of charging the roving, before going through the rolls, with a Holz machine. This had no apparent effect upon the spinning. I have also experimented with a large Holz machine (giving a spark 6¼″ long) upon cotton-roving. The only apparent effect was to make the loose fibres stand out more rigidly, and to somewhat increase the diameter of the roving.

CONCLUSIONS.

From the observations made by Quetelet, we see that atmospheric electricity is less during the summer months than at any other season of the year. For the month of December, he found the electrification to be over twenty-four times as great as for the month of July. Unless there are rapid variations during dog-days, there should be less trouble from atmospheric electricity at this time than at any other season of the year.

The atmosphere of the spinning-room where the above tests were made was charged from the belts to a potential of several thousand volts. The charge due to atmospheric electricity must have been very small (not over a hundred volts), since there was not a rapid admission of air. Its effects upon the spinning can therefore be neglected, when compared with the electrification due to the belts.

The experiments made with the Holz machine go to show that the roving may be charged to a high potential, and yet not have any effect upon the spinning.

I have made no quantitative measurements, since it was impossible to obtain an instrument suitable for such tests in time to be used this summer. A portable electrometer (like the Thompson's portable electrometer), according to Professors Trowbridge and Cross, would be the best instrument to use.

The PRESIDENT. Gentlemen, you have heard the report of Professor Fisher. I will say that he is prepared to answer any questions you may desire to ask; and the report is now before you for your acceptance and consideration. There is a report accompanying this by Mr. Gill, on the amount of moisture in the cotton and atmosphere, and also a report on the atmospheric electricity by Mr. White. Perhaps they are too technical to be considered here at this time, but would be of great value printed.

Mr. DRAPER. With your permission I will ask one question of the gentleman, and that is, whether he has arrived at any conclusion that he would recommend as of any practical advantage to the manufacturer.

Professor FISHER. It is a question of dollars and cents, entirely. I don't know how much this trouble amounts to in a mill in dollars and cents. It can be very readily calculated how much it will cost to remove the trouble. As I remember, it is something like a dollar a week for every thousand spindles, if you remove it by means of ice; and, if it is worth a dollar and a half a week to the mill to have it done, it can be removed: if not, it had better be endured, I suppose.

Mr. EDWARD ATKINSON. Mr. President, I think one thing has been pretty well proved, and that is, that very few men know any thing about this subject; whether we shall know any thing more when we get through remains to be seen. I would

ask Mr. Fisher if there was any opportunity, during the period of his observations, to test the adverse condition of too little humidity, or rather, I should say, of a low degree of moisture in the air?

Professor FISHER. There were no such observations reported. The smallest amount of moisture reported from any mill, as I remember, is that where the dew-point was about 50, where there were .58 of a pound of water present in 1,000 cubic feet of air. I do remember, that, last winter, down-stairs, we frequently had cases where the temperature was about 80, and the relative humidity was very nearly as low as 25. Now, if the temperature were 80, the amount necessary to saturate it would be about 1.6 pounds, and, if the relative humidity were 25, the actual amount present would be about .4 of a pound, corresponding to a dew-point of 40. We didn't have any dew-point coming down anywhere near that. It will be noticed, also, that the variations in absolute amount of water carried are very much smaller at a low dew-point than they are at the high dew-points.

Mr. ATKINSON. It seems to me, Mr. President, that a connection between the absolute amount of moisture in the air at a given temperature and the spinning of cotton, has been established, or partly established. In answer to Mr. Draper's question, Mr. Fisher gives a statement in dollars, which, I understand, applies to a room of twenty-four thousand spindles.

Professor FISHER. One dollar per week for every thousand spindles.

Mr. ATKINSON. One dollar a week for a thousand spindles: twenty-four dollars a week would have kept a room with twenty-four thousand spindles in good condition. That seems to bring the matter within the reasonable consideration of practical men. Now, then, it seems to me that if there is found in this report a basis for any sort of deduction like that, there should be warrant in continuing the course of investigation through the bad month of November and through the winter, when trouble occurs from very different causes than those which obtain in dog-days. The practical question before the Association, therefore, is, first, whether we will have all this matter printed in detail; and secondly, whether there is enough in it to continue it through the year.

Mr. PRAY. There are some things there, Mr. President, that

are very interesting to me, and I am sorry that I didn't know Mr. Fisher hadn't some knowledge about the quantity of water and vapor that cotton will take up under different conditions. I could have furnished it to him in an hour. I think, as Mr. Atkinson has suggested, that this Association can afford to go one step further. We have heard from one side, and not the worst side, either. Take it in December, with the temperature down to four or five degrees below zero; drop your windows four or five inches, and reduce the temperature in your room twenty degrees; reduce to the minimum the amount of moisture,—and you will reduce your spinning from five skeins a day to two and a half a day, and you cannot put help enough upon twenty-four thousand frame-spindles to keep them running. I think it will be an advantage to this Association to have the other side of the year. I am not directly interested in spinning: I am, I think, indirectly; and I think if the matter is carried through December and the snapping days of March, we will get information which will be very much more valuable than that we already have. If we can benefit by the little experience these observers have, and extend the sphere of observation, we will get facts in comparison with which these are very insignificant.

Mr. LEIGH moved that the report be printed. Carried.

Mr. LIPPITT. If the gentleman's motion did not include the supplementary reports, I would make a motion that they, also, be printed. I think we ought to have the whole thing in a permanent form for reference. Carried.

Mr. ATKINSON. I move, merely to bring the subject before the Association, and test the judgment of the members, that the board of Government be authorized to continue this series of observations, if, in their opinion, it be considered worth the necessary expenditure within the limits of the ordinary assessment. I would say here, that a society has been organized, entirely aside from this Association, for taking observations as to the conditions of the atmosphere, of which Mr. FITZGERALD, one of the superintendents of the Boston water-works, is a member; and he is present with us to-day. Some very curious results have been reached by the observations and investigations of that society that I think are not generally known. One, for instance, is that, at a certain period every night, whatever the condition of heat or temperature may be, the atmosphere is satu-

rated; and it may be that there is a very positive effect from that cause upon the condition of the cotton in the factory. There are, also, a good many other observations coming from the work of that society. They have demonstrated that many of the readings heretofore taken have been inaccurate, and that the work done in measuring rainfall has not been of much service. There might be some alliance made with that society whereby the expense could be diminished and the observations extended. I make the motion, not to press it, but to test the sense of the Association, that the work be continued, if, in the judgment of the Board of Government, it is expedient.

The PRESIDENT. At an expense not exceeding what assessment?

Mr. ATKINSON. At an expense not exceeding the ten dollars. Of course, I mean by that not to render an extra assessment necessary beyond the ten dollars. We are accustomed to pay five dollars; but we leave a leeway of five dollars with the Board of Government, if they see fit to make use of it.

The PRESIDENT. At the last meeting of the Association, the Board of Government was authorized to levy an assessment of ten dollars to defray the expense of these observations. The expense so far, elaborate as the report is, has not exceeded the five dollars, so that we have not been obliged to levy the extra assessment of five dollars. The whole expense is inside of five hundred dollars thus far.

Mr. ATKINSON'S motion was carried.

The PRESIDENT. The first subject for discussion will now be taken up. The reason for putting this question in the negative form is, that, so far as possible, the discussion may be directed to the weakest point, and, if possible, to stimulate the interest of our manufacturers and inventors in remedying the defect. Although several gentlemen have been invited to speak upon this question, and have manifested a willingness to do so, yet they hardly wished to be called upon in the meeting. It is to be hoped that all will enter into the discussion. The question is, "In which of these departments of cotton manufacturing has the *least* progress been made in the last twenty years; viz., picking, carding, roving, spinning?" Has any one any thing to say against, or in favor of, picking?

IMPROVEMENTS IN COTTON LAPPERS.

BY ALFRED CLARKE, LOWELL, MASS.

In considering this question, I shall endeavor not to trespass too much on the time and patience of this Association, but touch the salient points only, describing them when necessary, leaving the decision of actual improvement to men who have had a larger experience, to whom it would be presumption on my part to tender information.

I shall confine myself to a recapitulation of what has been attempted and accomplished, in the past twenty years, in this department of cotton manufacture.

Unfortunately for the honor of the present subject, it was just before that period that a revolution in the design of lappers took place. The question before us to-day, "In which of the four departments of cotton manufacture has the *least* improvement been made, — picking, carding, drawing, or spinning?" can be determined by finding out what has been the maximum of improvement in each department. This I shall endeavor to do with regard to picking.

I have found it impossible, in the limited time at my disposal, to particularize every thing which has been done; but I will endeavor to mention every thing of prominence. If, by inadvertence, I have omitted any thing which ought to have appeared here, I beg your indulgence and correction.

Assuming that the quality of picking to-day is as good as it was twenty years ago, the difference in its cost per pound would be a safe criterion of the improvement made. I have been unable to ascertain the cost of picking at a period more remote than 1871: before this date the cost of picking and carding were kept together. The cost of picking in 1871, in one of the standard mills, was two mills per pound; in 1884, $\frac{83}{100}$ mills per pound. The cost of picking has, then, been reduced $1\frac{17}{100}$ mills between 1871 and 1884. This reduction is 141 per cent of the present cost, and $58\frac{1}{2}$ per cent of the former cost.[1] These percentages represent the actual improvement. These figures, or this ratio, would not apply to every mill, I am aware; but I be-

[1] The average wages paid in 1871 was $\$1\frac{49}{100}$ per day of eleven hours, and in 1884, $\$1\frac{13}{100}$ per day of ten hours, being a reduction of $14\frac{8}{10}$ per cent in the cost of labor.

lieve it to be a fair average. This method would simplify the answer, and settle the matter, but would lack information as to the methods employed to bring it to this state. This I will endeavor to give as briefly as possible.

The object aimed at in cotton picking is, —

First, To separate the fibre from extraneous substances which are detrimental to the best working of the fibre.

Second, To so manipulate the fibres that they shall be perfectly separated, and free from curl or string.

Third, To place the fibres in the best possible form, for compactness and evenness, for the next operation — carding; non-injury of the fibre, and economy of labor, being important considerations governing the whole.

I will first direct your attention to the type of cotton-lapper which was in existence twenty years ago (by such well-known makers as Crighton, Lord, Platt, Walker & Hacking, and others, in England; and Kitson, Lowell Machine Shop, and Whitin, in this country), which nearly everybody present are familiar with, several such machines being in existence to-day; and, compared with the type of machines as built at the present time (by the firms already mentioned, supplemented by the firm of Whitehead & Atherton), to the casual observer very little difference exists; the type is almost identical, and the improvements made in the machines can only be appreciated by those familiar with their working.

"Openers," we are told, are only of increased capacity, the quality of the production being below, rather than above, that of the primitive "stick-whipper," and corded or slatted table. They have passed through the following stages: A mechanical imitation of the stick-whipper, "Cone-willow," "Oldham-willow," Hardacre's opener, a vertical cylindrical cage, with revolving arms fed from the top; the inverted conical cage, both single and double, fed at the lower or small end, delivering the cleansed cotton on the floor of the opening-room, from the large end: this is the well-known "Crighton opener." These were followed, in this country, by Calvert, Van Winkle, Jillson & Palmer, Kitson, Whitin, and others, being of a like type to those already mentioned, having revolving-toothed cylinders, flexible or jointed arms, and rigid arms; having no marked improvement over those which had preceded them; all cleaning well, but curling and stringing the cotton more or less; expensive

as far as labor was concerned, requiring a second handling of the cotton; also necessitating, from the nature of the operation, a quantity of loose cotton lying around, exposed to danger by fire. Succeeding these, came what might be regarded as an improvement, which was nothing more nor less than incorporating the existing forms of opener with the lapper. By this means the cotton was opened, operated by the beaters, and formed into a lap by one operation, reducing the risk by fire and the cost of labor. As an example of this class of opener, I will cite Lord Brothers' Horizontal Conical Opener, as attached to their lapper, and the "Buckley Opener," as attached to Taylor & Lang's Lapper. It will be observed, that in these cases the opener takes the place of a beater, and occupies a section of a lapper, — almost as much space as if detached. In the year 1878, Mr. Kitson introduced the opener known as the "Preparer," which was attached to the first section of a lapper, before the first feed-rolls and beater. This opener is possessed of all the important points, and has added to, instead of detracting from, the efficiency of the lapper, occupying but six inches more space, and economizing labor fifty per cent in the first lapper.

The trunk system was in vogue for opening and cleaning cotton before the war, and its cleaning properties were fully recognized; but it had to be abandoned for a time. The method employed in its operation consisted of an opener, to which was attached the trunk. The trunk, as used for this purpose, is an iron cylinder, or oblong, wooden box, divided its whole length by transverse grids; the cotton, by means of a current of air, passing along the upper division, the lower division having receptacles for sand, leaf, or other refuse, which may fall out of the cotton in its passage. Bale cotton was fed to the opener; and after passing the beater, or toothed cylinder, a blower-fan blew it through the trunk to a reception room, from whence it was collected, and spread on the apron of the first lapper. The cause of the abandonment of this system was the liability of the loose cotton to take fire, which it frequently did; and, whenever a fire occurred, it was in most cases attended with disastrous results, both to life and property. For this reason it was abandoned, and threatened to pass into oblivion. Lapper makers, recognizing the value of the trunk as a cotton cleaner, began to devise means for obviating the difficulty. The first

means used to this end was the application of the "condenser," applied by Mr. Kitson, which consisted of a pair of collecting-cages and a suction-fan, which collected the cotton, condensed it, and deposited it in close proximity to the lapper. The next step in advance was to connect the trunk with the lapper direct, thereby minimising the danger by fire, and reducing the cost of labor one-half. On this principle to-day, as adopted by the various makers of trunk-openers, it is the most effective and popular method of opening and cleaning cotton.

In comparing lappers, commencing at the "lap head" or "callender," this part remains substantially the same, being composed of two, three, or four press-rolls, with friction apparatus for compressing the lap; the only alterations effected in this section of a lapper being in strengthening the friction apparatus, and constructing the pressure-rolls with flanges for the purpose of moulding or compressing the selvage.

Next in order are the collecting-cages or screens. These have been constructed of various materials, in various ways,—of perforated tin and zinc; of wire netting woven in square meshes, of wire netting woven in square meshes and galvanized; of longitudinal wires, held in place by a warp of finer wire at intervals of about half an inch, forming oblong meshes: the galvanized netting being the latest and only difference (to my knowledge) to what were in use previous to the period assigned.

The general arrangements of the screens remain the same, some machines having two screens or collecting-cages, others one; in some cases the lower screen having the largest diameter, and in others the upper one being the largest, the Whitin lapper having but one large screen in each section, each maker and combination having its supporters. The makers of the "Whitin" machine claiming a "more even current of air," therefore a "more even deposit of cotton on the screen."

The suction-fans have undergone an improvement, so far as isolating the fan-shaft boxes from the suction-pipe: several makers have adopted this system, thereby preventing the oil being sucked into the pipe out of the fan-shaft box. Also has been invented and patented an "independent duplex fan." Instead of the fan being in the middle of the section as heretofore, a fan is placed on each side of the section at the termination of the side pipes from the screens. The inventors claim

that it is easier of access in the event of breakage, the fan spindles being not more than thirteen inches long by thirteen-sixteenths of an inch diameter; there is an absence of vibration, under high speeds, which is prevalent in the old method: the power needed is but one-fourth, a half-inch belt driving each fan with ease; and, further, it is easier to regulate the disposition of the cotton on the cages: either fan may revolve faster or slower as the case may require. This will be appreciated by those who are troubled with conical laps, or laps having thick edges.

"Feed-rolls" have passed through successive stages of fluted, pointed (i.e., having longitudinal and annular grooves), and plain, in single and double pairs; single rolls with concave plates underneath, both solid and sectional, the sectional plate being decidedly superior, holding the cotton equally at all points, irrespective of irregularities of thickness: concave plates, however, are only of importance where short-staple cotton is in use. I beg leave to incidentally mention at this point that at times within the period of this *résumé*, various methods and ingenuities have been resorted to, to meet certain exigencies. As a case in point, at the time of the war, when the cotton crop failed, and it was found necessary to import quantities of "Surat," and other short-stapled cottons, lappers were altered, hundreds of beaters were taken out, and replaced with what are known as Scratcher cylinders, in order to work such short fibre successfully. Several of these cylinders were retained because of their good service at that period, manufacturers forgetting that what was a positive benefit then, became a source of much mischief on the return to longer-stapled cotton. I would here respectfully submit to the consideration of agents, whether it would not be well to take into consideration the condition of the cotton crop, and regulate the lappers accordingly. It is well known that no crop of cotton is just like the one which immediately preceded or succeeded it: and yet, year after year, the beaters revolve at the same speed, likewise the feed-rolls; the same three or four thousand pounds of cotton per day is ground through the lapper, irrespective of the requirements of the staple.

In connection with feed-rolls, I must refer to one of the most important inventions of this period (that is, perfected within this period: I think it was invented in 1861), — Lord Brothers'

Patent Sectional Feed-regulating device, or "pedal evener," invented by Edward Lord. I need not describe it, for every one present, who is interested in the manufacture of cotton, is familiar with it. Until recently it has been, and is now, regarded as a standard device. "Noton's Sectional Flat-plate Evener" succeeded it in 1864; but this had defects, which have been remedied by the addition of a pair of fluted rolls, patented and adopted by Messrs. Whitehead & Atherton," and has since been known as the "Whitehead & Atherton Evener." The "Lord Evener" is known and used all over the world where cotton-spinning is practised to any extent. It has defects, though, which were inseparable by its construction, and led to the invention of the "sectional-roll evener," known as the "Clarke & Perham Evener," which has been extensively applied to cotton lappers. The "Lord" and "Noton" Eveners were sectional plate eveners, having a traction-roll over the plate to convey the cotton to the beater. Under certain conditions the cotton was liable to gather in front of the roll, and clog it. By the addition of a pair of fluted rolls, as in the "Whitehead & Atherton" Evener, this difficulty was materially lessened. By the invention of the sectional-*roll* Evener, with the positive driven sectional roll, having a traction above and below the cotton, the difficulty is entirely obviated. It has the advantage, also, of having the whole of the regulating mechanism above the lap.

One of the first most prominent departures from the ordinary rigid beaters, is the well-known whipper or flexible beater (Whitehead & Atherton), which has been extensively adopted, especially as an opener of cotton; the inventors claiming a yielding blow when the beater comes in contact with hard masses of cotton. The same firm also obtained a patent for using phosphor bronze links, as a prevention against fire when coming in contact with metallic or hard mineral substances in the cotton. Mr. Kitson replaced the flat beater-blade with a blade having the form of a semicircle (in section), the circular part being nearest to the shaft. This form is very efficient in preventing loading. A new beater has been recently introduced: the patentees, recognizing the fact that pneumatics, properly applied, are a large and important factor in the successful opening and cleaning of cotton, have therefore devised a beater having a perforated hollow steel shaft, whereby the air

is transmitted through the axis of the beater to the screens. Two very important objects have been attained by the use of a beater made on this principle, the first being as follows: instead of taking the whole of the air for conducting the opened cotton from the beater to the screens, through the grids, under the beater, a large portion passes through the beater shaft, thereby diminishing the current of air at the grates; thus allowing the lighter refuse to fall to the floor, which heretofore has been carried into the lapper again, and onward with the cotton. In the second place, this beater materially lessens the curling and stringing of cotton, so generally prevalent in lappers.

I will explain, for those who may not be aware of the fact, that the cause of curling and stringing is due to the vortex of air caused by the rapid revolutions of the beater, wherein a considerable part of the cotton is held and whirled until it is condensed, and, by centrifugal force, thrown forward to the screens, or through the grids into the waste, when a fresh supply takes its place: hence, this beater was designed to neutralize that vortex, by a straight or direct current of air from its axis, and permit the cotton to go direct to the screens. This perforated hollow-shaft beater, the independent duplex fan previously described, and the sectional-roll evener, are contributions to this department of cotton manufacture by Mr. Perham and myself, and are known as the Clarke & Perham patents.

Respecting the statement I made previously, that pneumatics were an important factor in cotton opening and cleaning, ingress of air to lapper rooms, and egress therefrom, in the form of dust-flues, dust-rooms, and chimneys, are worthy of the most careful attention by those interested in mills, as they are most important adjuncts of a lapper. A machine-maker may tax his ingenuity to its utmost limit to build a perfect lapper; and without a full and regular supply of air, and a free and uninterrupted outlet, all his efforts will be in vain. I am pleased to testify, that, in several new mills, agents have co-operated with the lapper-builder, in order to make their lapper-rooms everything which could be desired; whilst in other modern mills that I am familiar with, the most apparent careless indifference exists; which is a continual loss to the mills, and discredit to the lappers.

In the construction of new picker-buildings, I would urgently impress on the minds of agents and mill engineers the desira-

bility of dispensing with wire netting entirely in the dust-rooms, by having a dust-room thirteen feet high, and having a capacity of seventeen hundred cubic feet per fan; with dust-flues having an area of two hundred and sixteen square inches per fan, and dust-chimneys having an area of three square feet per fan, the air-currents will be so light that no waste-cotton will be carried out of the room: the outlet will be perfectly free at all times, and the picking satisfactory.

The PRESIDENT. Gentlemen will bear in mind the form in which this question is put; and, of course, it will be in order to speak upon either of these topics — picking, carding, roving, spinning — at any time during the discussion, the object being, you understand, to find out where our weakest place is, where we have made the least improvement.

Mr. ATKINSON. In making up a table, with which many of you are familiar, of the progress of a particular mill for forty years, the fact struck me most forcibly of the increasing capacity of your operatives; the number of operatives to a given amount of capital invested, and to a given mill, having kept substantially uniform, while the product went up from eight thousand yards of standard sheetings in a year to thirty thousand, and the wages advanced almost in a corresponding ratio. In one of the old books which I studied in order to reach these conclusions, I was particularly impressed with what must have been the condition of the carding many years ago, by the enormous disproportion of overseers and second hands to the number of operatives and to the price paid. I am very sorry that I did not bring that old book down with me; but, as I recollect it, more than one-quarter of the cost in the carding-room was paid to overseers and second hands, the operatives earning forty-two cents a day at that time. And, throughout the series, you keep observing the progress of each operative in each department; this showing that, whatever may be our weak point now, a vast progress has been made. The change in the carding is very noticeable, as shown by the old book to which I have referred. My assumption from it was, of course, that the card was a very much less automatic machine, and that it required a very much larger proportion of skilled mechanics to keep the cards in order then than it does now.

Mr. DRAPER. I have some faint recollection that I had some

communication or suggestion from the Board of Government, that they would not object to my having a few words to say on this occasion. I propose to speak, somewhat, on the question of improvement in the making of roving. As my recollection goes back for twenty years, and I understand the discussion to be limited to that period of time, I think we may take the fly-frame as the standard roving-machine of the world. Although the speeders in this country are doing a great deal of work, and are supposed, in certain lines, by very skilful manufacturers, to be superior to the fly-frame, yet the fly-frame is the machine more largely and more generally in use the world over. There may have been improvements in certain directions, such as the improvement of the long collar to sustain the spindle; but the substantial construction of the fly-frame is very much, in some particulars at least, and in some makers, the same now as it was twenty years ago. I have no doubt the builders and users could point out some details of change; but, in the main, except for superior construction, the machine could be made to do as good work then, it could be made to carry as heavy and as long a bobbin, and to revolve with as rapid speed, as now. What I am about to say is, that, while that has been the case for the last twenty years, I think we have arrived at a point where there is to be a very decided new departure on the question of making roving; and, if that does not come within the province of the question before the meeting, I don't desire to say any thing further now on that subject. If it is within the province of the question before the house, why, then, I would say something further upon it. I will leave it for the chairman of the meeting to decide.

The PRESIDENT. I presume that any improvement which has been adopted, even though it may be by one or two, and put in use at all, and has exhibited any improvement, would be proper to speak of here. If it is a matter that is purely prospective and experimental, then it does not come within the province of this discussion. I will leave that for the gentleman himself to answer.

Mr. DRAPER. This improvement has been already adopted to a considerable extent, and has, therefore, passed beyond the boundary of experiment. Not that some additional and needed improvements might not immediately be made upon the machines now in use. What I refer to is the improvement in

the flyer of a speeder spindle, called the Foss machine, very extensively in use in the new mill of the Hamilton Manufacturing Company of Lowell. It is claimed by those using fly-frames that they can make a better quality of roving on a fly-frame than can be made on a speeder. The fact is, that on the fly-frame you have the flyer and the bobbin and the spindle all combined, and any tremor or trembling affects the whole of them together; whereas, it has been said, and it is true, that in the speeder you have the fixed flyer, you have the spindle and the bobbin an independent factor; and if there is a tremor to a spindle, as there is at high speeds, and especially with heavy bobbins, then you are liable to stretch the roving, especially at the top, owing to this vibration. What Mr. Foss has done is to put the bobbin on a shaft which is held rigidly at both ends, so as to prevent any vibration from the spindle. This is something of the same improvement that was made in the common spindle by supporting the spindle higher up. That same improvement had been made in the fly-frame: that is, they had made the long collar to support it higher up; but the bobbin was not fully supported. Now, by supporting this, we have this rigid, solid shaft, with a slot made in it, and there is no danger of its bending. What is the object of that? The object of that, of course, is to enable you to run a bobbin of this size (exhibiting one) without too much tremor. Every one here knows that when you are running a bobbin on an unsupported spindle at a given speed, you increase the speed, and you increase the tendency to tremble; you increase the weight, and you do the same thing; you increase the length, and you do the same thing to a very great degree. Now, to overcome that difficulty, and make it possible to increase the length, this invention comes into play. And the fact is, we have reached the point where we can run a bobbin of that length and weight of roving at the same speed that a size smaller is now run. This roving (exhibiting a sample) was made on a flyer running something over twelve hnudred turns a minute. Now, I maintain that a spindle, unsupported at the top, with that small bobbin, will tremble one hundred times farther from the plumb centre of that machine at twelve hundred turns than this other will at twelve hundred. The fact is, that is rigid. You can't make it tremble. Now, this is going to enable us to make a good deal more roving in the same time on a given machine, and it is going to enable us

to put a good deal more fine roving on a bobbin; and I believe the time isn't far distant when you will spin directly from bobbins of four and four and a half hand roving with as much on it as there is on that one. I can see no difficulty whatever in the way. The bobbin was 9½ inches traverse, and 5 inches diameter.

But what I want to call your attention to most, is this. I have in my hand one of the reports of the proceedings of this Association for the year 1876. There is published here a paper prepared by one of the most useful members we have ever had, a man who has retired now, as I understand it, from business, full of years, and with his pockets full of money, as I think he deserves: I refer to William A. Burke, one of our former vice-presidents. He read a paper before this Association in 1876, in which he compared the cost of production of two mills, one in 1838 and one in 1876, on substantially the same work. And it is to his closing remarks on that occasion to which I desire to call your attention. What he says is a better speech than I could make, and so I adopt it, applying it to the result that is likely to come from this. He says: —

"The reduction of at least one-half of the piecings in the progress of the cotton from the bale to the cloth. We now make longer laps, and use larger cans for the drawing sliver; by improvements on fly-frames and on speeders, we double, at least, the length of roving laid on a bobbin, and thus enable a spinner to tend more spindles. We double the length of yarn wound on a quill or bobbin; we wind three times as much weight of yarn on a "section" or "slasher" beam, and we double, at least, the number of cuts or pieces on the warp-beam for the loom."

Now, then, I think I have said enough, so that every practical man can see what I am driving at. I will simply announce that we have one new machine complete which we shall exhibit at New Orleans, which has been running in the Hamilton Company. We are so sure of our position that we are going ahead to get out patterns, and make the machines. I will also say that we can build a machine that will carry any amount of cotton that you want to put on a bobbin without any trouble, if it shall be found of any use. And now a word about doffing. With the fly-frame, you have to go and knock off each individual flyer, and then go around, and put them on, and fix them again; and

you are lucky if they don't fly off when you don't want them to. But this is just as easily doffed as the Lowell machine-shop speeder, which parties are familiar with. A girl can go along and take off these bobbins, one with each hand.

The PRESIDENT. Is there any danger that the spindles will fly out of the socket?

Mr. DRAPER. There is no danger of any trouble of that kind.

The PRESIDENT. Is there any gentleman present who is prepared to defend carding or to attack carding? I understand a gentleman from England is here, Mr. John Butterworth. He is familiar with carding, and perhaps he will give the Association the benefit of his experience. I wish he would say a word.

Mr. BUTTERWORTH. I came here, not to speak, but with the expectation of hearing something from the gentlemen of the Association.

Mr. GARSED. There seems to be a good deal of the Quaker meeting style to this discussion; and, as nobody else seems inclined to say any thing, I rise, although I have given but little attention to the subject under consideration; in fact, only within the last four days was I aware that it was going to be discussed. As I understand, the subject before us is not, What is the best machine? it is, What has had the least attention or the least actual improvement within the last twenty years? Now, I take it that the cotton card has had the least attention, successfully, of any machine in either of the branches named in the call. I will take up the subject of the Wellman card, as we have it to-day, and compare it with the card we had forty years ago. All that can be claimed for it to-day over the card of forty years ago, is the Wellman stripper. I fail to see that we do the work any better than we did. If you except the iron cylinder and the better making of the card, up to to-day we have really made no other improvement than that of the Wellman stripper. We still have the miserable hand-stripping of the cylinder, as crude as it is possible for any thing to be. Efforts have been made, as I am aware, but not successful, to strip the cylinder, and keep it in order for its work without hand stripping. The Gambrel stripper was adopted years ago, was fashionable for a time; but it has died out, because the work was not as well done by it as by hand. And now, while we are stripping our top-flats automatically, still the cylinder must

be stripped by hand. Again, the top-flats, on nearly all American cards, are still made of wood. I need hardly say to practical men in this room, where the difficulty comes in there, particularly in a time like this, when we are stopping our mills two or three weeks together, and then try to start up with our flats sprung so they have to be stripped of their wire, and planed up before we can proceed again. The machine-makers have been short in this matter, with all the improvements in their tools. We ought to be able to work to the one-ten-thousandth of an inch in accuracy; but that has not been done with a cotton-card yet, as far as I am aware. We have the same poor, miserable screw to regulate our flats, screwed sometimes into wood, and sometimes into iron; coarse threads, rough on top, so as to catch all the fibres of cotton; and, of course, when the machine comes down, after being stripped by the Wellman stripper, it falls upon a pile of cotton on the top of a screw which prevents its coming down a hundredth of an inch, when it ought to come down to eighteen-hundredths of an inch. No effort has been made to correct this, except, some years ago, some one of our machinists (I don't know whether it was myself or not) raised a flange, and tried to keep the cotton from getting under the flats on top of these bolts. You will find that our favorite card commonly takes a notion to make buttons, as we call them. The doffers are unprotected from the currents of air either way until the cotton is collected in little buttons, and gathers and gathers till it spoils our work by getting in through the railway head.

Now, surely there ought to have been some effort made to correct these evils. I judge, Mr. President, that the reason it has not been done is in that weakness in our policy as manufacturers which leads us to economize in the price of machines. Instead of asking the machine-maker to give us better work, more accurate work, which we should be willing to pay for, we go on this miserable system of taking off ten per cent, or five per cent, or two per cent, till the machine-maker cannot give us the machinery he is able to with his modern tools. The feed-rollers of the Wellman card are to-day precisely as they were when I first knew them, and that is a good while ago. No effort has been made to prevent the lapping of the rollers where we are doing double carding. I have been in a hundred mills, probably, where the roller is lapped half-way along, where the

cotton is dragged through in lumps, between the feed-rollers, and prevents the roller binding in the centre. On some of their heavy-weighted cards they have a concave plate and roller in it. The failure of that plate was for the same reason, — neglect to make better work in this country. They did not plane the plates out, or bore them out accurately to the diameter of the roller, so it would hold the cotton at all points. The effort made to regulate the machine by a sectional feed and roller, if applied to a cotton-card, would probably be a very great improvement.

I make these suggestions for the benefit of any machinist in this room, on the same principle that the suggestion has been made here for other improvements which the makers have adopted, but which the Association is entitled to the credit of bringing out. But I am very sure that we shall have to turn back, and pay more attention to the accuracy of our machinery, and to the exactitude of its workmanship, than to the price. You are all aware that if a machine is thoroughly well made, it only takes one half the attention that a poorly-made one does, to say nothing of spoiled work. If it were possible to make a card do its work perfectly, we would probably need no double carding. Within a few days, we have a little machine at the mill which gins the cotton, cards the cotton, and spins the cotton on bobbins turned by hand, for the benefit of benighted regions like Africa. The cylinder is about a foot long, and six inches in diameter; and, to my astonishment, the cotton was pretty thoroughly carded. Then it occurred to me that the thirty-six or forty inches of flats around a Wellman card might be a little too much, and whether one quarter of it isn't enough. Nevertheless, a great many cards have been made that had double the quantity of flats. I am beginning to think, with my friend Johnston, that we have a good deal too much carding on each card to-day. I am satisfied we have, if we only had the workmanship of the card better done, so that when a man or a boy set it, he would know what he had. I am sure there is scarcely a gentleman in this room, familiar with cotton-spinning, who will not bear out my assertion, that the Wellman self-stripping card is about as crude a machine as can be found in a cotton-mill.

I have spoken, sir, not so much to show the way out, as to provoke discussion on this subject.

Mr. LEIGH. Mr. Garsed has alluded to a style of card that is in existence, and has been for nearly twenty years, and has become familiar to nearly all manufacturers; and that is, the revolving flat card. As Mr. Butterworth is here, he can tell us of the progress of that card in England, where there are over twelve thousand of them at work. The original patent is out, but recently there has been a very important improvement made in that card, which *dispenses with the chain*, and allows *the flats to go close together* on the cylinder; thereby preventing the *waste* and *fly blowing out*, and keeping the *card clean* where it was otherwise dirty. There is also a new method of setting it. All the flats are set at once. They are all cut alike. There are no screws to each plate, but they are set by what is called a flexible bend, which is concentric with the cylinder; and that is set at five places each side of the card, and the flats run in a groove, which keeps them in their proper places. All the flats are set at once by turning a handle. The screws that connect these setting-places are coupled by chain-wheels and chains; and, by turning a handle around once, it lowers the flats on each side, all over the cylinder, $\frac{1}{800}$ part of an inch. This is a great improvement in the card. We are going to have one at the New Orleans Exhibition. After that, I purpose presenting one to this Association, so that the members will have an opportunity to examine it for themselves.

As the revolving flat card is well known to many in this room, and has been put into use in some mills recently, I should like to hear from the superintendent of the Arlington Mills, who has lately, I understand, taken out a large number of Wellman cards, and put in some of these revolving cards. I would like to hear his experience. I would like to hear also from Mr. Butterworth, who must be familiar with English cards in use; and I think you will say, when you have heard from these gentlemen, if they express the opinions I hope they will, that a great improvement has been made in carding. When I was in England, fifteen years ago, one hundred cards, producing from three hundred to four hundred pounds each per week, only required three men to tend them. They did the grinding, setting, stripping, and all the labor required. You see that is a great advance; but recently improvements have been made, so that they don't even require as many as three men to one hundred, where they produce a medium quantity.

Mr. ATKINSON. I should like to have the question divided into two parts, the first question to be as to the quality of the carding machine itself; each of its own kind, and aside from its principle. The observations which I made in England, especially in the shop of the Hetheringtons, which I referred to a year ago, confirmed what Mr. Garsed has said. Every cylinder of the Hetherington card is not only turned to a true surface, but the special arch which is to go with that particular cylinder is also ground to an adjustment with that particular cylinder. Now, in my judgment, there isn't a card built in this country, no matter what its kind, that comes within forty rows of apple-trees of that extreme accuracy in its mechanical adjustment.

The question at issue is this: "Is the American carding-engine as perfect a machine of its kind as the English machine is of its kind?"

The other question is, "Which is the best method of carding?"

Mr. REDFORD. It seems to me there is very little difference between the card that is made to-day, either here or in England, except as to the one point of accuracy. They use a licker-in, they use a cylinder, they use a doffer. But in this country they haven't taken into consideration the accuracy which they have in England. Now, with regard to the American card, I should like to see a man who could set a series of top-flats, and set them all with one bevel in them, and have them standing on four legs. The top-flat of the American card is fixed up like a table, — it stands on four legs; and, if you once move it, you have got to prop something under it. The English card is not arranged to have two set screws at each end and a pin going through the flat and behind where the flat rests, on each side of the pin that goes through the flat: it simply has one slide-bracket which is set in the side; and, when the bevel of the flat is once set, it is always set. Now, every time an American grinder sets a top-flat, when he disturbs it, he has got to set that flat so it won't overlist. Now, I claim that a man who can set a series of top-flats, and set them so they won't rock, could do something else, — he could run a bank. I have seen the cards on the other side, and I have seen the cards on this side; and there is really no difference between them except in the point of accuracy. There is one thing which they don't use on this side which they use on the other side, and that is, the under

casing. I don't know why they can't use it on this side; by not using an under casing, we can't get the same production, for we can't run the cylinder so fast, or it will throw off. The arrangements for setting a card are so primitive that it takes a good man to set it, and set it as it ought to be done. In England you can make a first-class grinder in about three months; you can't make a first-class one on this side in three years, because he has got so much more to learn. With regard to the card which we are now using, — we are replacing the Whitin card by the Hetherington revolving flat. I don't know that there is very much difference between the Hetherington and the Dobson and Barlow revolving flat card. I had almost as soon have one as the other, but the Hetheringtons were the last to begin making them; and with the improvements they have put on, they have succeeded in making a very good card. With regard to the practical benefits of the revolving flat card, there is no lifting up of the top-flats. You can have the flats with any bevel you like, and there is no possible way in which it can get out of place. Every thing is bound to be accurate, after you once get it so; and there is considerable advantage over the ordinary wooden card. My objection to the wooden top-flat is, that it will go either one way or the other with any change in the temperature; the wire will be all ground down in one place, and it won't touch in another.

Mr. C. I. Barker. I was a little surprised to hear the remarks of our friend from Philadelphia (Mr. Garsed), that there has been no improvement in a cotton-card, to speak of, for the last forty years. Now, I am not a very old man, but I can look back to the time when I first went into a cotton-mill, and remember that the first cards that I stripped (or, rather, I think I carried the laps to the card) were eighteen inches wide; the cylinder and doffer both were of wood, and there was a sort of a crank arrangement for a can; and the whole thing was a very crude article. When we wanted to turn up our cylinders, if they didn't seem to be true, one of the boys would take a machine, and hitch it on, and turn it up by hand, and take the doffers out in another place, and turn them up by hand. Now, this is within my remembrance. And, not only that, but they were put in line, and had a can to each card. These cans had to be transported a certain distance across the mill to a series of drawing; and it was one continual tug and pull from morn-

ing till night, on that system. Now, it does seem to me that we have gained a great deal since then. We have come down through various stages of the flat card, until, in my judgment, the common flat card — as built by the Whitins, or the Saco Water-Power Shop, or any other good builders (these I am practically acquainted with) — with the Wellman stripper, with the licker-in or not, as required, with the railway box and the railway head attached, shows us vast improvements. While their cylinders may not all be turned quite so nicely as they turn them across the water, still, I think, as constructed, — especially by the Saco Water-Power Shop, — they are very accurate indeed. Within a year I have put in two or three hundred; and we tested them, before they were clothed, with a point, — had it done very carefully; and out of the whole lot I didn't find more than one or two that were out any to speak of. We called them good enough, — not perfect by any means; but I have yet to see any machine, or anybody, that is absolutely perfect. I have worked on English fly-frames and on English cards; and certainly I never saw any perfect. I have yet to learn that perfection exists in common machine-shops, or in any shop, this side or the other side of the water. Therefore, I rise more particularly to express myself with regard to this improvement on cotton cards. I cannot conceive of any machine in the cotton department, or, in fact, in a cotton-mill, that has been improved more than the cotton-cards, — the various kinds of cotton-cards, — for the last ten years. We used to think, when we had a card of thirty-six inches that had twelve tops, that that was a great improvement over the eighteen-inch cards that had twelve tops, and the twelve-inch doffer; finally it was changed to twenty tops and fifteen-inch doffer. There was a great improvement, not only in the running of the card, but in the work you could produce on it. I know very well, in the old mill, where we had thirty-six-inch cards, with twelve tops and twelve doffers, if we could produce twenty-five pounds to a card, it was considered good work. It would hardly be considered up to the modern standard of forty-five pounds to a card on a thirty-six-inch card. Therefore, I think there have been very great improvements in cards.

I never have had any especial practice on revolving flat cards; but I have seen some revolving flat cards that seemed to me not exactly suited to this latitude, to say the least.

Mr. BUTTERWORTH. I will offer a few remarks only upon this matter. Of course I am not prepared to go into minute matters, in a comparison of your carding with ours; but what I wish to say is this, — that there is something about it which is entirely different from ours. I am alluding now to the finished work, to the results. I am not alluding to any mechanical detail; only I may say, that, in passing from one mill to another, I have observed certain mechanical defects in connection with your cards, that we haven't in ours. But the final result of the carding is different from ours. What I mean by that is, that there is a rawness which we don't experience, as a general rule, from our modern cards. There is a rawness in the carding from your modern cards that I don't notice in ours. It always grates on my feelings to see cotton come from the card looking as if it had hardly been near the carder. I know that you are wedded to your style of card; but there is something about the revolving flat card, — something about the principle of it, and something about the working of it, — which, I think, if you were to take it into careful consideration, would lead many of you to change.

I have one remark to make with respect to your picking, in comparison with ours, and that is this, — I find that the average number of beaters you use is something like five or six: with us it is from three to four.

I never had an opportunity to look into but one of your scutchers; and, to say the least, I was shocked upon looking into it. However, I have only had the opportunity of looking into this one; but that, I believe, is only two or three years old. The point I wish to bring before you is this: that, while we clean cotton considerably dirtier than what you have here, and work with three beaters, or four beaters at the outside, you use six or seven. There is something wrong there. I don't know whether the machines you are working with are the result of the suggestions of the men who have to work them, or are simply machine-makers' machines. Of course, if they are simply machine-makers' machines, I would not pick them up out of the street; but, if they are the result of practical observations, then it is all the greater pity. That is all I could say with reference to that.

Taking the whole thing collectively, I must say, that, as regards picking and carding, you are hardly in the race to-day.

So far as spinning is concerned, perhaps I would not go so far in my statement; but I don't believe you even give spinning a fair chance; that is, comparing the ring-frame with the mule. If you take the cost of the production, you have it on the side of the ring-frame at once, because you compare the small mules—you compare with mules of from five hundred to perhaps eight hundred spindles; whereas, if you put them beside our mules, you have to compare with a mule of fourteen hundred spindles. And the talk is of going even to a greater length than that. However, that is not a matter which has been gone into. But as these are, perhaps, the only remarks that I shall make, I thought it an opportune time just to mention the matter.

Mr. ALFRED CLARKE. I am a manufacturer of lappers, and there are card mauufacturers and other machine makers here. Mr. Butterworth has condemned the American-made lapper as compared with the English-made lapper, and I will ask him (for he is a practical man, and he must know, if he has looked into the American lapper) where the difference exists between that and the English? I will tell Mr. Butterworth that I understand both machines thoroughly. I can tell him the dimensions of almost any machine he can mention; and I fail to see, myself, where the wide difference exists which calls for the invidious comparison he has made with regard to the American lapper. I can assure the gentleman that there is no such poor work put into any part of our lapper as there is into the English machines I have seen. Better work is done at our foundries on castings than some of the finished work on English machines. I would ask Mr. Butterworth to point out to me any one instance of superiority in workmanship in an English machine, and, with regard to the results of the latter, to tell me where the difference exists between an English and an American machine with three beaters. I have yet to learn where the difference exists, either in the arrangement or in the architecture, as we might say, of the machines. I will challenge Mr. Butterworth to produce a machine from England that contains the high quality of workmanship that the American lapper, which I will produce, contains.

The PRESIDENT. I will remind the gentlemen that this is not a discussion of the relative merits of American and English machinery. It covers the whole question of improvements

in machinery in all departments during the last twenty years; and I hope that no further invidious comparisons will be made.

Mr. BUTTERWORTH. If the President will excuse me, I will not go into the discussion at all. I rise to correct my friend, and to say that my remarks were confined to general results of the work from the different processes. I am not here, at all, to recommend English machinery. I didn't come here for that purpose, and it is not my intention. In fact, speaking as an Englishman, — that is to say, belonging to England and with the idea of remaining ever so, — I should say to you, "Stick to your ideas: it is all the better for us." I would just make one little remark with regard to construction of lapper machines by Americans (and it applies to other machines as well), and that is this, — you take an English invention, and you will work it over; you will make this alteration and that alteration for the very purpose of making it into an American machine. Any thing that goes in this country must be American. That is the fact of the matter, so far as my observation goes.

Mr. GARSED. Mr. President, I am delighted. First, I want to address my friend Barker. He says that some years ago each card delivered into a single can, and that can was carried to the drawing-frame; and he cites it as a very great improvement, that we now have railway heads and these lines of cards delivering into a great mass of cotton, to be drawn by a pair of drawing-rollers. I have no doubt that he thinks it is a very great improvement, but I differ from him very widely indeed. I am by no means certain that we hadn't better go back to the single card to each drawing-frame, and let the railway head go to the four winds of heaven. I want now to say a word to my friend Leigh. I have watched his father's invention of a travelling flat card for a great many years, almost from its inception; and the great difficulty in that card has been, so far as my judgment goes, the utter impossibility of making the bends flexible. Notwithstanding they call them flexible, you cannot possibly make it concentric with the cylinder shaft, unless you make every single inch of it flexible. If you can, please tell me how. I don't think you will find a man among very many who will have the ability to set them. You cannot have the bend entirely concentric unless you have it divided up small, say, probably, one inch. So much for that.

Now, I did not say a word, when I was up before, as to

whether the English card was better than the American, or the French, or any other. I said that the card was crude. It is as crude as it was twenty-five years ago, so far as accuracy of workmanship is concerned. The gentleman says that we must not expect perfection: I don't say we should, but I will tell you how perfectly some of these things are working. A few days ago I was at the electrical exhibition in Philadelphia. Pratt and Whitney had a lot of gauges there in which I took considerable interest; and the gentleman who had charge of the exhibit took a gauge out of the case with a piece of steel that just fitted in; but, the moment he applied his thumb and finger to cause expansion, it dropped out. That is what we are doing in this country, and that is what I wished to provoke this discussion for, and to keep it going. Show me a card where the cylinder is put upon the shaft by means of a cone, — or any other means, except the miserable set screw, — that any man living can tell how long it will remain accurate. I want to see that on a Wellman card made by a machine-shop in this country. This is a point that wants attending to. I won't say any thing about the size of the doffer, for the nearer we get the doffer to the size of the cylinder, the better card, I think, we will have. I think when we have a travelling flat card, with the bend flexible and concentric with the cylinder, we can probably find an American who will have brains enough to manage it, or any other machine that is made on the globe. I think so. But we have been trained in this country to make machines that were fashionable with the public. The Wellman card is understood by nearly every American grinder. If the English card would work better than the American, we certainly would adopt it after a while; but it doesn't seem to be adopted. There are some in this country, and some are wonderfully well made and wonderfully well handled; but they are exceptions to the rule. As I said before, it takes a skilled man to handle it. I have nothing more to say at present.

Mr. Atkinson. I was somewhat surprised, Mr. Chairman, at the observation made by Mr. Butterworth with respect to the excessive number of beaters in the opening and picking room in this country as compared to England. I suppose he will admit, that a few years since there were many more beaters applied to cotton in England than there are to-day in their scutcher department, and that there has been great progress

in diminishing the number, and in less working of the cotton there now. I think, if he examined a little farther, he would find, that, in the best practice in this country, the number of beaters in the opening and picking room has been as much reduced as it has been in England, and that the best practice in this country corresponds very nearly with the practice in England on that point. There is also another point that rather surprised me; and I think we ought to thank Mr. Butterworth for coming out so frankly, and making this discussion. He says we get an English machine over here, and attempt to convert it into an American machine. So we do, and we do it rightly. We had the misfortune, in past years, to import ring-spinning from England; and some gentlemen, I don't know whether they are in this room or not, have the misfortune of attempting to run it at the present time. As compared with what Mr. Draper now builds, there would be no comparison. There has been vast progress. The attempt was made in England to import the American ring-spinning machine, and to convert it into an English machine; and the first examples of that were what I didn't care to characterize, and which those who now use them wish they had never imported. The ring-spinning machines which I saw in England seven years ago were as different from the ring-spinning machines there and here now as chalk is from cheese. We are discussing the progress in twenty years. The enormous progress in the construction of the ring-spinning frame in England has been fully equalled by the progress that has been made in the construction of the same machine here. But, when you come to carding, I ask any manufacturer here if there has been that progress in the mechanical construction and in the accuracy of the adjustments of the American card, that there has been in the construction and accuracy of the American ring-spinning frame? I think you will all say there has not. But, so far as the English card is concerned (not comparing one system with another, but speaking merely of the card itself), there has been as great progress in its mechanical accuracy and adjustment, as compared with its prototype of ten years ago, that there has been here in the construction of the spinning-frame; and it is in the perfection of the carding engine of the present day that, I think, they are excelling us more than in any other department of the factory — if they excel us anywhere else, which I doubt.

Adjourned for noon recess.

AFTERNOON SESSION.

The members re-assembled at the hour appointed, and the discussion was resumed.

The PRESIDENT. During the discussion thus far, an attack has been made upon picking and upon carding; but none has been made upon roving or upon spinning. If any one has any thing to say against either of those departments, we should be glad to hear it. I suppose Mr. Draper can tell us as much against spinning as any man.

Mr. DRAPER. I beg the pardon of the presiding officer, but I don't think I fully understood what he said.

The PRESIDENT. We should like to know, sir, whether spinning has kept pace with the other branches during the last twenty years. Some of us think it has not.

Mr. DRAPER. Perhaps I am not as good a judge, Mr. President, as some others in regard to the matter; but one thing I am sure of, — if it hasn't made good progress, it isn't because I have not given my best endeavor to make it. A gentleman said to me the other day, — and there is no harm in mentioning it, because you can judge better after that: it was with reference to the treasurer of the Dwight Mills, — that, with substantially the same number of spindles, he was producing forty per cent more, in consequence of the changes he had made in his spinning department within a comparatively few years. And he was doing it without any practical additional cost for labor, and at a saving of power from what he was using to begin with. Now, that indicates the real state of things.

The PRESIDENT. During what period do you say?

Mr. DRAPER. During the period of ten years. The element of spooling in connection with spinning has been improved by the improvements in spinning almost as much as the spinning itself. The spinning has not only been improved, and the cost reduced, both in the labor and in the power required to spin yarn; it has also been very much improved in quality, and the waste lessened very much. The ordinary ring spindle that was in most extensive use for spinning warp yarn at six thousand turns, made a great deal of slack yarn; and the bobbins were inclined to rise up on the spindles, and make a great deal of waste in winding out of its proper way. As you can see, if

the bobbin should lift up, it would wind down low on the taper, and all become loose and tangled. With regard to the spinning of the filling, and the progress that has been made in that department, I am not so well prepared to speak; but this I can say, that I have no doubt but what in this country, without regard to what may be said of any other countries, that the improvement in the cost of spinning and in the cost of weaving, in connection with spinning of filling, is very much greater than it is on warp. In fact, I believe that you could better afford, if you were going to build a print-goods mill to-day, to put in mules, to spin your warp, and put in the best constructed frames to spin your filling, than you could to turn them around the other way, and spin your warp on frames, and your filling on mules. We have this so we can get statistics about it now. We have a large mill; in fact, the new Flint Mill in Fall River. Twelve or fifteen years ago, they told us we could not make proper print goods, unless both warp and filling were spun on mules, that there was a certain softness about it. Then they went on, and became thoroughly convinced that they could make cloth that would answer the purpose of printing; and almost all printers, those that made their own cloth and printed it, made their warp on ring frames, and the filling on mules. Now we have come to a state of things where they make both warp and filling on mules; and I am told that the goods from that mill have the preference over any other goods that are made in the Fall-River market. At the same price buyers will take these goods in preference to the others every time. They are weaving more per loom than any other mill is weaving, or has woven in Fall River, in consequence, as they claim, of its being made on frames, and run on bobbins in such a way that it don't break so much in the shuttle; and it runs so long that the weavers prefer it in that way. And the last estimate I had of the whole cost, taking in the filling and the warp, — No. 36 filling and No. 28 warp, — was only one and one-eighth a pound on the average, the whole cost of spinning.

The PRESIDENT. You mean the picking and the carding?

Mr. DRAPER. No; I mean in the spinning-room simply.

The PRESIDENT. You said just now that a party had made a statement that he was doing forty per cent more work than ten years ago in his spinning.

Mr. DRAPER. Yes.

The PRESIDENT. How much of that forty per cent is due to the improvement in spinning itself, and how much is due to improvement in other departments.

Mr. DRAPER. That is a question that I could not answer without referring to the gentleman himself. I can only say that, in his conversation with me, he made no reference to any special improvements in the other departments?

The PRESIDENT. There is, no doubt, some of it due to that.

Mr. DRAPER. Well, I am the poorest man in the world to talk about what I don't know about: I prefer to say I don't know. I heard a gentleman make an interesting statement the other day, which, although perhaps not exactly germane to this, I will repeat. A reliable man told me, that, on the question of weaving print-cloths, he was getting his weaving done at just one-half the price per yard that they paid in 1863, and that his weavers were making some two dollars a week pay more than they made in 1863 at double the price per yard. That would give you a good indication of the improvement that has been made in that department.

A gentleman suggested that the difference between a gold and silver basis might have some connection with the statement just made. Mr. DRAPER replied: I can only say that the gentleman did not refer to that. The probability is, that had not begun to have much effect in 1863; if it had, the price would have been higher than it is now. He didn't say in gold; he simply made the statement. I will say who it was: it was Mr. Danielson, Mr. Lockwood's son-in-law, treasurer of the Danielson Mills, and also treasurer of the Lockwood Mills, in which I have an interest. He told me he got his cloth woven now for eighteen and a half cents, and he told me how much he paid in 1863; and you have all I know about it. If you will excuse me, gentlemen, from saying any more, I will retire.

Mr. ATKINSON. Mr. Draper has referred to one interesting fact. You all think that you employ your operatives. That is a great mistake: *they employ you.* They employ you to place the best machinery at the lowest cost, to put it in operation. You secure from it, each year, a less and less proportion of the price of the goods, a less and less rate of profit on your investment; you relieve them from the arduous and noxious conditions of labor by every sanitary device that can be discovered

and applied; you divide the gain, which ensues from invention and improvement in part to the consumer of the goods, and all the rest is disposed of by increasing rates of wages. The analysis of the figures of any factory, especially of a factory which has gone on successfully from the beginning for its owners, without having its capital stock cut down, and without going through the process of bankruptcy, will prove this statement. Reference has been made to the higher rate of wages in the use of modern machinery in the mill of to-day as compared with 1863. The question asked is not absolutely answered by Mr. Draper, and probably cannot be here, as to the ratio of that advance; but this is the fact, that good weavers in good employment to-day receive a larger share of the joint product of labor and capital in money, in gold coin, than they did in mock money, or greenbacks, in 1863, 1864, and 1865. If you take each series of five years, subject to such temporary fluctuations and variations as the one which we have upon us at the present time, you will observe that the steady effect of the employment of the capitalists by the laborers, is to secure such conditions for their benefit as will give them a constantly larger and larger share of the product, higher rates of wages, and better conditions of life. I think it would be exceedingly interesting for any man who is in charge of a mill to-day, to do as I have done with certain old records, — get out the old books, and trace down the increasing quantity of machinery per operative, the decreasing cost of labor per pound or yard, and the increasing rate of wages, which mark every five years for the last fifty years. Fortunate it is that it is so; for, after all, of what use would capital be to the world, except it did result in benefit to the wage earners, who constitute fifteen out of sixteen of the whole working population?

I said to Mr. Draper, as we left the room at the close of the morning session, that the trouble with carding-machinery and the like in this country had been, that it hadn't happened that any Sawyer-Draper combination had taken hold of the carding-room; and that we should reach the same results which I think we have reached in the improvement of spinning, when a Sawyer-Draper combination does take hold of the carding-room, and accomplish what that combination has accomplished in reference to spinning. Now, I want somebody to attack that proposition, and pitch into Mr. Draper, and not into me.

Mr. BUTTERWORTH. Mr. President, I should like to say a word; and it is more to correct Mr. Atkinson in one or two remarks that he made this forenoon, than it is to make any further remarks upon what has been said this afternoon. If you remember, he asked the question about the number of beaters; and he said, or at least I understood him to say, that his experience was, that they had very much decreased the number of beaters in America during the last few years from what they had used in former years; and I also understood him to say that he questioned very much the correctness of my statement. However, let that be as it may, he seemed to question that you were putting cotton through as many as seven beaters, and claimed that you had decreased the number of beaters considerably, I think one-half. Well, if that be so, from what I saw the other day, at one time you must have been putting cotton through something like fourteen beaters. That has come under my own observation in the last few days. That is, I have seen cotton put through seven beaters, — the porcupine cylinder and six beaters. Now, I don't wish you to go away with a wrong impression, thinking that I am endeavoring to stretch any thing here. I am not doing so. I say that the general rule is from five to seven beaters in this country, as far as I have been able to observe. In England it is from three to four.

With regard to ring-spinning and ring-filling, an idea has occurred to me while I have been sitting here. I have no need whatever to repeat my views upon the question, because you know them. But I have just been thinking, should I happen to come to America in October, 1894, I should not be surprised to hear a question up before this Association as to the difference there was between your finished goods then and the goods you made in 1884. That is to say, there will be something different about your finished goods then, from what they are now; something peculiar, a better finish, or something which you do not quite understand. I should not be at all surprised, in 1894, to hear a question of that kind raised. Now, the Bradford spinners say to-day, so far as I am informed, that it is very unfortunate that they have gone into the French system of spinning their worsted yarns. It is very unfortunate that they have done so. A few years ago their trade was entirely locked up in consequence of the French goods taking the place of their hard,

smooth goods. And so it is with fashion. Fashion goes around in constant changes; and I maintain that it is impolitic for anybody to attempt to force a certain class of machines upon the community, or upon a lot of spinners, in opposition to other forms, when it is known that the two systems of spinning are entirely different, one from the other, and produce two entirely different results. My argument is this; I believe in ring-spinning, but I am also a believer in mule-spinning; and I don't think you will ever be able to do without either. With regard to ring-frames, in point of cost, I acknowledge, that, so far as warps are concerned, you can produce them more cheaply than you can upon the mule; but, as far as spinning is concerned, it is a question whether you can do it more cheaply, or whether it is advisable to do it even if cheaper.

Mr. GARSED. I should like to ask Mr. Butterworth whether mule-warp will sell in England, alongside of ring-warp of the same kind of cotton, at a reasonable difference in price?

Mr. BUTTERWORTH. Ring-warps won't sell at all in England, for you can't make them to sell. You can't send them away on the bobbin; and but one mill yet has attempted to sell ring-warps on the beam, and I believe that is a failure.

Mr. GARSED. I would modify the question a little, and ask what would be the result with flyer-yarns and mule-yarns, of the same number and same quality of cotton.

Mr. BUTTERWORTH. I don't think there is one mill in England that uses the flyer-yarns now. If they don't use mule-warps, they use ring-warps; and that is the extent to which ring-spinning is coming largely into use. That is to say, mills that make their own warps are putting in ring-frames for their warps in preference to putting in mules, but not for filling. We have one or two instances of firms that have tried the ring-filling; and, for certain classes of goods, it answers the purpose. It does not answer for other classes, neither does it here. I have had facts brought to my notice which I intend to make use of after I get home. I cannot go into them here, because I wish to give the matter a careful consideration.

Mr. GARSED. I was simply trying to get at the difference in price between mule-warp and ring-warp, so that we might have something to judge by. What prejudice, if any, is there against mule-warp?

Mr. BUTTERWORTH. There is no prejudice against mule-

warp, bear in mind. It is the cheapness of the cost. When it comes to the question of weighting the warp, the mule-yarn is preferable. The mule-warp will take more size than ring-warp will.

Mr. GARSED. That is what I wanted to get at. We know nothing about weighting warps in this country.

Mr. BUTTERWORTH. I don't think you know any thing about weighting warps; and, if that is a matter over which you can laugh, you are quite welcome to it. But allow me to tell you this, — the manufacturer in England is an abused individual, if there is one in the world. The sin of weighting does not lie at his door. But I will tell you something more through one of your papers about that matter some day. You may look out for it.

Mr. DRAPER. We might turn the gentleman's remark, that he hoped we would keep on using certain cards, and say that we hope the English will go on spinning their filling on mules instead of ring-frames.

Mr. BUTTERWORTH. I believe we can afford to do that. I believe we can afford to keep to our mules, because it is my impression — and I have seen nothing yet to remove that impression — that you can do more with a mule than you can with a ring-frame.

Mr. DRAPER. I presume you can do more with any thing than we can.

Mr. BUTTERWORTH. I don't think so at all, and I don't want you to get into that spirit. I have just been having a few words with Mr. Atkinson about a matter of that sort. I didn't come over to this country with the idea of creating enemies: I came over with the expectation of making friends, and I should be very sorry to go back under any other conditions. I say that I have seen a great deal that I admire in this country, — a great deal. I concede that it is a big country. I find everybody that I meet with, on every hand, makes use of the same expression, — that it is a big country. And it is a big country; but, as I said to Mr. Atkinson, the people know it too. They don't forget it. I am afraid that is what makes you look so very little, in the eyes of other people. I say it with every good feeling: don't think I am at all personal about this matter.

Mr. ATKINSON. I sent down to my office, and have received

two or three documents which I thought might throw some light upon this discussion as a whole. The question is, To what extent has the general improvement in machinery in each of the four departments increased the capacity of the average operative. I hold in my hand the pay-roll for twenty-six weeks of a standard sheeting-mill, for the six months ending Nov. 27, 1830, in which each department is reduced to day's labor and to dollars. And I observe in Mill No. 1, in the carding-room, overseers and second-hands did 1,977 days' work for $1,915. The total days' work was 5,422. In Mill No. 2, there were 2,078 days' work of overseers and second-hands out of a total of 5,324. You will observe that the overseers and second-hands earned a dollar a day at that time: the machinery was operated from thirteen to fourteen hours a day, and the operatives in the room, — the speeders and lap-tenders, etc., — earned an average of from forty-four to fifty-four cents, averaging, perhaps, fifty cents a day. The greatest disparity, of course, is in the carding-room. The proportion of overseers in the weaving-room was 638 days' work to 14,000 days of all others. Therefore, you observe that the greatest progress must have been made in the carding, even though the carding be the most deficient department at the present time. Now, that book furnished the basis of the tables which I published, going to show that wages had increased from $164 gold, for thirteen and fourteen hours' work a day, in 1820, up to $290 gold in 1884, as far as we have gone. And notice how the capacity of the operative has increased, from 4,321 yards a year of standard sheetings to 28,032 yards, almost 30,000 yards, owing to the changes which have been made. This is all shown here in this table, together with the cost. Most of you have seen it. Perhaps it is presumptuous for me to think it would be worth perpetuating in your records; but I should be glad to have it done if anybody thinks it worth while. Now, we will pass on to see what this all means. What is the ratio of operatives to spindles and product, in point of number? In taking the census in 1880, while all the documents were in my hands, I sorted the mills south of the Potomac from the mills north of the Potomac, and made such corrections as, in my judgment, seemed to be suitable for the various differences; and the final result was, that for the same work there were thirty operatives, plus a fraction, to a thousand spindles south of the Potomac, and fifteen operatives, minus a

fraction, to a thousand spindles north of the Potomac. Now, if we could get some such comparison as that with Lancashire, we should have a pretty certain standard as to who is ahead. I have here a book which was loaned to me by another English gentleman who is here; but how much it means, and what it means, I do not yet know. I observe, that in Oldham, in 1883, there were 72 of what are called the co-operative spinning-companies owning 5,133,000 spindles out of about 11,000,000 spindles which there are in the town. In these 72 mills, there are, according to this book, 14,794 operatives employed. Now, divide 5,132,000 by that, and we get a proportion of $2\frac{9}{10}$ operatives to 1,000 spindles. This number, of course, only spins the yarn, and does not weave it or dress it. It includes the carding and spinning. If this book is to be depended upon, the ratio of operatives to spinning-spindles is less than 3 to 1,000. Now, how much is it over here?

Mr. DRAPER. A girl will tend 1,000 spindles here in spinning.

Mr. ATKINSON. I put the question as a question to be considered. When I was in England, I observed that they have gone so far as to adjust the exact width of the mill to the exact number of spindles a mule will carry with the lowest cost of operation: 128 feet the width of the mill, and 1,058 spindles, I think. A man and a boy will tend 1,300 and odd spindles on a lesser gauge. I should like to ask Mr. Butterworth if that is about the ratio.

Mr. BUTTERWORTH. It is about a fair ratio, although it is rather less now than when that book was published. With regard to the length of the mules, a man and a boy will tend 1,400 spindles; the ordinary mules carry between 1,000 and 1,100, and sometimes exceeding 1,100 spindles.

Mr. ATKINSON. It is my impression, that, for the accomplishment of the work they undertake to accomplish, — it may be work we don't want to accomplish, — their work is done with less proportion of operatives to a thousand spindles than the work is done here. How much that means, if it means any thing, I cannot say; but, so far as quantity is concerned, of sufficiently good quality for the purposes for which they want it, they have reduced the ratio of operatives to the number of spindles to less than ours. On the other hand, I am inclined to think we have reduced the proportion of operatives to a thousand looms in a degree greater than they have there; so,

when you come to balance the whole, it may be about the same. But, as we are now considering the advantage of one system of carding or spinning over the other, this ratio may be a factor in the computation. You will observe that any attempt to compare cost by way of a comparison of rates of wages, may be utterly fallacious. Rates of wages are lower in the South than in New England; but if twice the number of operatives is employed, how does the rate of wages affect the cost of production?

Mr. PRAY. I have been listening, hoping that some one else would bring this point up here. We have had the cards on the floor, the machine-makers have been slapped between the eyes; but nobody has yet said who can card the poorest cotton, and make the best yarn. I am not in the business now; but, in years gone by, as you know, I was among the largest importers of English machinery. I am just now figuring on a new American mill; and, from all appearances, the carding will be English. The treasurer of the concern arrived in New York last week, after spending two or three months in England, and he has brought me back some stunning figures, — there is no use putting any other adjective to it. We talked this morning about the old Wellman cards, and we can talk about all the others; yet what my friend Garsed said this morning remains perfectly true. There is too much wire in contact with the cotton. The English print-cloth makers will take a certain proportion of Surat cotton that there isn't a man in this room can spin to a No. 8 yarn with American machinery — they take their grades of Brazilian and East-Indian cotton, with about fifteen per cent of ordinary American cotton, and make No. 32 yarns. There isn't a mill in Fall River, Lowell, Nashua, Manchester, or anywhere in the United States, that can make good standard print-cloths out of it. Now, if we are so far ahead, why can't we do it? I am not interested to-day in any man's machinery, and I have no personal motive in advocating an American card or an English card. Now, there is another thing connected with English carding. I am sure several of the gentlemen present who have recently been in England cannot but corroborate what I am to say, and Messrs. Atkinson, Draper, Weeks, and others, have lately had opportunity to see and realize it; and that is, that, in the modern English mill, they card a good deal more per card of an inferior grade of cotton,

and do their work for less dollars and cents for each and every hundred skeins or hundred pounds of yarn that they make, than we can do it here. I believe there are some interesting figures to be developed from that, if some of our members will make a study of it for the next six months, and get at the facts. The figures brought home by the gentleman to whom I have referred, show, that, in the modern English mills, they are opening, picking, carding, and spinning their cotton for less per thousand spindles than the best New-England men are doing, providing my information from parties to whom I applied is correct; and a detailed statement is now in the course of preparation. And the largest factor in the saving is in the carding and preparing the cotton. The gentleman does not believe they are ahead of us in the spinning, and I cannot say that he bears out all that my friend Butterworth claims with regard to the most modern mills. But it may be that Butterworth hasn't got hold of all our vagaries and eccentricities; and, possibly, my friend in the English mill has got a wrong impression in the same proportion. But, taking all the figures and the information we can obtain, it appears that they are doing their work more cheaply than we are; and I have figures up to 1884. Now, if this is the fact, it is not a question for us whether John Bull makes it, or Brother Jonathan; New-England manufacturers want to know it, and get what benefit they can from it. There are going to be a good many thousand cards ordered within the next few months, and they are not going to be ordered because this man or that man has got a patent. The test will be, How much can you card? how well can you card? and how much will it cost?

Mr. Pevey. What is the cost per pound of roving prepared for the spinning-frame with English machinery as compared with American? There are several gentlemen here from Fall River who are prepared to give figures.

Mr. Pray. I am not here to give any. I have only called the attention of some very intelligent gentlemen, yourself among the number, to the fact that there has been a sort of desultory talk here all day, but the one important fact has not been brought out yet; whether, with all the progress we are supposed to have made during the past twenty years, the comparison between the American and English systems is in our favor. I undertake to say that the Englishman will take a lower

stock than we can, and make a better yarn out of it. I would like to get some accurate figures from any New-England mill.

Mr. DRAPER. I fail to see the bearing of any thing the gentleman has said upon the question which is before the Association. He has brought up an interesting question, but I fail to see what relation it has to the topic before us.

The PRESIDENT. The Chair has allowed the discussion to take rather a wide range, for it has been almost impossible to confine it to the exact question. But the time has arrived when we should proceed to ballot, and I give notice that in five minutes that will be in order. If any gentleman has any thing to say in closing, we should be glad to hear from him. I will appoint Mr. Lippitt and Mr. Fisher to take charge of the ballot.

Mr. PRAY. I should hope that some committee might be appointed to take into consideration the subject to which I have called attention. Let us find out what it does cost us. My opinion counts for nothing, nor any other man's; but let us have the facts.

The PRESIDENT. That is a question outside the limits of that now under consideration.

Mr. PRAY. I understand that, sir.

The PRESIDENT. If no one desires to speak, we will now proceed to a ballot; and I hope that every gentleman will vote. I will state the question again, so there may be no mistake as to its form: "In which of these departments of cotton manufacturing has the *least* progress been made during the last twenty years; viz., picking, carding, roving, spinning?" In depositing your ballot, you will deposit the slip on which is printed "picking," "carding," "roving," or "spinning," according, as in your judgment, it has made the least progress during the past twenty years. It is intended to cover the whole field of cotton-manufacturing, and to apply to progress anywhere.

The vote was then taken, and the result was declared to be as follows: —

Whole number of votes	29
Picking	3
Roving	7
Carding	19

The PRESIDENT. The next question for discussion is, "How should the common 36-inch top-flat card be constructed and operated to produce the best results; viz., As to size of doffer?

Size of cylinder? Speed of doffer? Speed of cylinder? Weight of lap? Draft? etc." This question was proposed at the request of some gentlemen who are anxious to get the best results from this kind of a card; and, inasmuch as probably nine-tenths of all the cards in New England are of this kind, it has been thought desirable to get the opinion of gentlemen of the Association as to their best use.

Mr. ATKINSON. Although I have had to swear off from exhibitions myself, there is an exhibition about to open in New Orleans, which, it seems to me, this Association ought to take some notice of.

The PRESIDENT. I would remind the gentleman that the question before us is the question of carding.

Mr. ATKINSON. I will move, then, that that question be laid upon the table. Carried.

Mr. ATKINSON. I now make a motion that a delegation be appointed to attend the New-Orleans Exposition on the part of this Association. I move that a delegation be appointed, of which the president shall be chairman, to visit the exposition; and that, unless members can be nominated here now who are sure to go, the Board of Government be requested to appoint members who will make up the committee. Carried.

The PRESIDENT. We will now take up the question of carding. There must be some gentlemen present, among all these manufacturers, who are committed to the use of this 36-inch card; what is known as the Wellman top-flat card. Some are using it to better advantage than others. We cannot all order new cards within the next sixty days or a year: we may not be among those who will order some of the thousands of new cards spoken of. Some of us must stick to the old cards. Now, some manufacturers know how to run these cards better than others do; and I know that there are gentlemen here who want to know exactly how to build, adjust, and run the common 36-inch top-flat cards. It is a question of some importance, although not of as great importance as some of the questions that come before us. Will some gentleman who has struggled with this matter give us the benefit of his experience?

Mr. GARSED. I am at present using 36-inch flat cards, after having used the English roller card. Up to the present they

appear to be entirely satisfactory; but, when we come to read over the statistics reported by the Oldham spinners to their stockholders, and learn that in Oldham they are using a 40-inch double cylinder card, and selling 40's yarn at 18¾ cents a pound, and making dividends, it does seem that there must be some reason for it that doesn't appear on the surface. Is it in the card, the additional quantity got from the card? is it in the additional length of mules? or where is it? We must not confine ourselves to the flat card. Invest the same amount of money in the Wellman card that you do in an Oldham card, and what would be the result? It seems to me that there is something in the economy of cotton-spinning, that we, in this country, haven't yet got hold of; nevertheless, our wages are, probably, as sixty-two is to a dollar. That is, we pay a dollar where they pay sixty-two cents, as far as I can judge. But that doesn't cover the ground that the president suggests. We have got these cards, and must make the best of them. If you put more than forty pounds a day on the 36-inch card, you will spoil your work; and, therefore, if we are going to get more carding for the money invested in the cards, we must first find out what the Oldham card does to make No. 40 yarn of the stock they use. I am not by any means certain we could manage the English card upon the material they use on the other side, and make No. 40s.

Mr. Redford. I don't think it is altogether in carding, in England, but there is a good deal in the mixing. When I was there, I noticed that in the picking-room they have more machines with fewer beaters; that they are more particular in mixing their cotton, and are more particular in putting it through different machines, and doubling it; and, by that means, they get a better lap than I have ever seen elsewhere. The carding is practically the same that it has been for thirty years, the principle is the same. My impression is, that it is the mixing and the careful picking, and not too much picking. They have an opener that makes a lap. Then, they take three of those laps, and put them through a single beater-picker with a fan; then they take four of these laps, and put them through an intermediate single beater-picker, and make another lap; and then they take four of these, and put them on a finishing machine. There they have four operations with pickers. Now, in this country, just to save a little labor, you put two or three

beaters into one machine; and I think that is where you make a mistake, and that is the reason why you need more beaters, in the aggregate, to do your work. I think you could do your work better if you put it through three separate machines. It would cost a little more, but I think the result would be better.

Mr. BUTTERWORTH. I don't know that I am prepared to go fully into the matter of cost in England in comparison with America; but I can give you an instance of a mill of ninety revolving flat cards, managed by four men, with the addition of a man to carry laps, and another to take up the fly. These four men have the sole care of those ninety cards, producing seven hundred weight per card per week. The work is good; and, when I say that it is good, I mean what I say. With regard to the cost of your picking-rooms, as compared with ours, a rough estimate of what you do and what we are doing is this: that ours costs no more than, if as much as, yours; and particularly in some concerns where a great deal of handling of the cotton must be done before it comes to the machines. The arrangements that we have are different from yours from the very beginning. Then, as regards the quality and the character of the cards we put in: we put in a certain class of cards for a certain class of work. A mill is expected to go onto a certain class of goods, and they put in a certain card.

The PRESIDENT. I should like to ask Mr. Butterworth if he knows any English builders who are putting in the American card, — what is known as the top-flat card?

Mr. BUTTERWORTH. I don't know of a single American card in use there.

The PRESIDENT. Not an American card, but an English card upon the same plan?

Mr. BUTTERWORTH. I don't know of but one American card, and that I understood was put in more as a curiosity than any thing else, to experiment upon to prove its practicability. And, by the way, an idea just occurs to me with reference to a remark that was made by a gentleman here this forenoon, Mr. Clarke, about the hollow beater being a new invention. I can tell you it is an old one: it is five or six years old, and existed in England, under another form, long before it came over here, that is, in the form of an open cylinder, which accomplished the same end, exactly, that he claims; but I don't know of a single machine that is working to-day.

Mr. ATKINSON. I think Mr. Butterworth misunderstood the president's question, which was, whether there are any cards used in England built on the American principle.

Mr. DRAPER. I have been informed that Mr. Wellman had received a large amount of money from England for his stripper; and, I believe, that is a matter of common information.

Mr. BUTTERWORTH. You are referring to the Wellman card as an American: there are a few Wellman cards in existence there, and there are a few made. The only makers I know of are Dobson & Barlow. I was over there a little while ago, and I asked them if they made a large quantity of these cards, and they told me that they made a few; but what they did make, they said, went principally abroad.

The PRESIDENT. I should like to ask Mr. Butterworth what comparison he would make between a mill fitted out with the Wellman card, and one fitted out with the revolving top-flat card. That is, if one mill is fitted out with the Wellman card, and prepared to spin No. 40, and another with revolving top-flat cards, all other conditions being the same, will one mill have much advantage over the other?

Mr. BUTTERWORTH. I should say the one with the revolving flat card would have an advantage as four would be to five.

The PRESIDENT. Would it be appreciable?

Mr. BUTTERWORTH. It would be appreciable, certainly, because, in one case, you have nothing to disturb. You go to a card, and stop it, and in half a moment you have the cylinder grinding; and, during the operation of carding, you grind the top-flats, and they are prepared ready for their work again. The card is constantly kept up to its work. It is always, as it were, in one condition, with the exception of the state it gets into when it wants to be cleaned.

The PRESIDENT. What do you mean by saying it would have an advantage as four would be to five?

Mr. BUTTERWORTH. I mean, in point of labor, you would want five men in the one case, where you would want only four in the other.

Mr. REDFORD. It is two to one where the men work side by side.

Mr. BUTTERWORTH. All the mills I know of in England which have had the Wellman card have taken them out, and put in the revolving flat.

Mr. REDFORD. The best margin they have had in Oldham for the last four or five years is four and a half cents between the price of the cotton and the price of the yarn; and you have got to get your waste and every thing out of that.

Mr. PARKER. There are several mills in this country using the common Wellman top-flat card, arranged for double carding, and spinning average No. 32 yarn, where the total cost of labor for picking, carding, and spinning will not exceed 1.8 cents per pound.

Mr. REDFORD. The selling price in England is sixteen and a half cents, and I should like to see anybody who will spin the same quality of stock in this country at that price, and make a dividend.

Mr. PEVEY. I should like to know if they enjoy over there making 40s yarn with a margin of only 4½ cents per pound between cotton and yarn sold?

Mr. REDFORD. They manage to pay a dividend, and have about as good a time as we get.

Mr. BUTTERWORTH. I will give you credit in this country for making very nice cloth: your goods look very well. I was going to say that it wasn't you who were doing it, but it was your cotton. That is to say, you use a class of cotton we should be glad to finger in England for many classes of goods.

The PRESIDENT. England buys our best cotton.

Mr. BUTTERWORTH. It does not. You don't give England a chance to buy your best cotton. You have better cotton throughout the States, so far as I have been able to see, than we ever get for similar classes of goods.

Mr. ATKINSON. I don't believe the two statements are inconsistent. I suppose England does buy the very best cotton for fine working: special men are employed to buy the best cotton grown in the Mississippi Valley.

Mr. BUTTERWORTH. For special goods, we have men out here after cotton regularly: that I admit. But when I spoke, I meant, so far as No. 32s are concerned, we would be glad to have a cotton equal to what you are making your 28s out of.

Mr. PARKER. I should like very much to bring out the difference in cost of operating a Wellman and a revolving top-flat card, and can give, approximately, the cost of double carding on a Wellman card. There are mills carding 45 or 50 pounds per day of finished work, where the cost of carding

alone, including grinding, stripping of cylinders once a day, and a boy for taking care of the delivery side of the card, and keeping the alleys clean, does not exceed one-third of a cent per pound.

Mr. REDFORD. I don't see how we can compare figures of the cost in this country and in Oldham. The English people, generally, don't go in for doing carding cheap; they go in for doing it well, and putting in a machine that will make the best work from the poorest grade of cotton. The English people spend more money on their carding and drawing than we do; after they get it past the drawing, then their economy begins to come in. I don't see how we can manage to make a comparison understandingly. They believe in giving the wire a chance to discriminate between the fibre and the dirt which is in the fibre, which they think the wire hasn't a chance of doing when the sliver is in a thick sheet on the wire.

Mr. PRAY. It isn't necessary to go to England for the figures, for Mr. D. J. Johnston of the Harmony Mills has them so he can give them, approximately at least. He has, also, a range of numbers from six and a half to seventy, so he can cover the whole ground. I can give you the figures of three southern mills and four northern mills, with all the facts concerning the carding from the bale to the speeder, and including the speeder.

Mr. ATKINSON. It is rather hard to think of figures in the midst of discussion. When Mr. Butterworth made the statement that the cost of No. 32, for labor, was nine-tenths of a penny, it at first struck me as very low; but I didn't think quick enough. There are plenty of mills that work at less than two cents a pound for 32 yarn in this country. That brings us to a very important phase of the matter. If it be true that we work at nine-tenths of a penny, or 1.8 cent, on a Wellman card, in competition with Oldham on the English card, then you come down to the real point which Mr. Butterworth brings out, — Do we use better stock in order to produce the same result? My observation is, that we do use decidedly better stock in order to produce the same result. In other words, we do not clean dirty cotton, and get it into good form at that price. But what of it? We can afford to use better cotton. When you come down to 1.8 cent per pound, our advantage of half a cent a pound — which is the paramount advantage

of New England as compared with Lancashire—in the price of cotton, enables us to use cotton a half a cent a pound better on our machinery, in the same work, and get the advantage of it. There is where our advantage comes in. Now, then, if we are nearly on a par with each other, using in Oldham the English carding system, and in this country the Wellman card, then the question comes, What will be our position when the American card is built as accurately, and adjusted as finely, and is made as good a machine, of its kind, as the English card is of its kind? There is where we want to bring about a combination of the Sawyer-Draper kind, in order that every improvement in the carding engine may be forced into notice.

Mr. DRAPER. I must object to my friend Atkinson bringing me in to do better than anybody else, but I will do the best I can every time.

Mr. ATKINSON. I have told Mr. Draper a good many times that he is one of the "necessary evils" of the cotton-manufacturing of this country. He has done more to benefit it than any other man who ever lived. I am inclined to think that the best justification of patent laws is, that they hasten the introduction of improvements by making it for the interest of sagacious men to promote them in a way which the inventors themselves are seldom capable of.

Mr. PEVEY. The drift of the discussion here seems to have been in favor of English machinery; but I am an American, and I claim that American machinery is better than the English. I think the superintendents here will bear me out in saying, that American machinery will run better, and at a very much less cost, than the English. It costs less per pound to bring the cotton into goods with American machinery than it does with English in this country.

Mr. PRAY. I am an American, and I would naturally prefer to buy American machinery. But, if the English machinery is capable of doing so much better work, I want to know it; and then it is my business to study how to accomplish the same thing.

The PRESIDENT. Our discussions have not been, in all cases, to the point to-day; but it is to be hoped that some good will come from our deliberations. Is it your pleasure that the debate be now closed, and that the Association adjourn? Carried.

[No. 38.]

N. E. COTTON MANUFACTURERS' ASSOCIATION.

PROCEEDINGS

OF THE

TWENTIETH ANNUAL MEETING,

HELD AT BOSTON, APRIL 29 1885,

PRECEDED BY

CATALOGUE OF MEMBERS.

BOSTON:
WRIGHT & POTTER PRINTING CO., STATE PRINTERS,
18 POST OFFICE SQUARE,
1885.

BOARD OF GOVERNMENT.
1885.

PRESIDENT.

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HENRY F. LIPPITT . . . . . WOONSOCKET, R. I.

AUDITOR.

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SECRETARY AND TREASURER.

AMBROSE EASTMAN . . . . . BOSTON, MASS.

Office of the Association, Room 68, Sears Building, Boston.

MEMBERS OF THE ASSOCIATION, 1884.

HONORARY MEMBERS.

George Arms		New York City.
Benjamin F. Nourse		Boston, Mass.

ACTIVE MEMBERS.

Stephen I. Abbott	Lockwood Co.	Waterville, Me.
William Ames	Fletcher Manuf. Co.	Providence, R.I.
Edmund L. Anthony,	Border City Manuf. Co.	Fall River, Mass.
Edward Atkinson		Boston, Mass.
George Atkinson	Massachusetts Mills	Boston, Mass.
A. T. Atherton		Lowell, Mass.
H. C. Atwood	Williamsville Manuf. Co.	Killingly, Conn.
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William P. Bancroft		Wilmington, Del.
A. D. Barker	Warren Cotton Mills	West Warren, Mass.
Cyrus I. Barker	Bates Manuf. Co.	Lewiston, Me.
W. A. Barrell	Lawrence Duck Co.	Lawrence, Mass.
Stockton Bates	Bridesburg Manuf. Co.	Philadelphia, Penn.
F. F. Battles	Massachusetts Cotton Mills	Lowell, Mass.
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John Birkenhead		Mansfield, Mass.
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Thomas J. Borden	American Print Works	Fall River, Mass.
Thomas S. Borden	Metacomet Mills	Fall River, Mass.
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Stephen N. Bourne	Stark Mills	Manchester, N.H.
Samuel C. Bowdoin	Hampden Mills	Holyoke, Mass.
Erastus Boyden	Prescott Mills	Lowell, Mass.
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Edward A. Brigham		Boston, Mass.
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E. C. Bucklin	Harris Manuf. Co.	Providence, R.I.

William D. Cadwell	Jackson Co.	Nashua, N.H.
George Callaghan	Angora Mill	Philadelphia, Penn.
George A. Chace	Shove Mills	Fall River, Mass.
Simeon B. Chase	King Philip Mills	Fall River, Mass.
Alfred D. Chandler		Hartford, Conn.
Thomas C. Chandler,	Windham Cotton Manuf. Co.	Willimantic, Conn
George A. Clark	Manchester Mills	Manchester, N.H.
Jeremiah Clark		Lowell, Mass.
Alfred Clarke		Lowell, Mass.
F. E. Clarke	Pemberton Co.	Lawrence, Mass.
J. G. Coburn	Hill Manuf. Co.	Lewiston, Me.
Francis Cogin	Augusta Factory	Augusta, Ga.
John A Collins	Perry Manuf. Co.	Newport, R.I.
D. E Converse		Glendale, S.C.
A. G. Cumnock	Boott Cotton Mills	Lowell, Mass.
James W. Cumnock	Dwight Manuf. Co.	Chicopee, Mass.
John Cumnock	Great Falls Manuf. Co.	Great Falls, N.H.
A Dahlgren	National Manuf. Co.	Nashville, Tenn.
A. W. Danforth	Shanghai Cotton Cloth Mill Co.	Shanghai, China.
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E. S. Davis	Continental Mills	Lewiston, Me.
B. D. Davol	Pocasset Manuf. Co.	Fall River, Mass.
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George Dexter	Pepperell & Laconia Cos.	Boston, Mass.
George Draper		Hopedale, Mass.
William F. Draper		Hopedale, Mass
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Charles L. Eaton		Providence, R.I.
Isaac Eaton		Nashua, N.H.
Herbert R Farnum	Bernon Manuf. Co.	Georgiaville, R.I.
Herbert Fisher		Taunton, Mass
M. F. Foster	Langley Manuf. Co.	Langley, S.C.
Philip H. Fowler	Gloucester Gingham Mills	Gloucester, N.J.
J. Dwight Francis	Pontoosuc Manuf. Co.	Pittsfield, Mass.
Frank H. Fries		Salem, N.C.
Melville Gambrill	Arlington Mills Manuf. Co.	Wilmington, Del.
William B. Gambrill,	Druid Mills	Baltimore, Md.
A. J. Gardiner	Danielsonville Cotton Co.	Danielsonville, Ct.

James G. Garland		Biddeford, Me.
Richard Garsed	Wingohocking Mills	Philadelphia, Penn.
James A. Gary	Alberton Cotton Mills	Baltimore, Md.
Charles J. Goodwin	Indian Orchard Mills	Indian Orchard, Mass.
Alfred M. Goodale	Boston Manuf. Co.	Waltham, Mass.
David Gowdey		Providence, R.I.
Benjamin Greene	Cabot Manuf. Co.	Brunswick, Me.
Frederick Grinnell		Providence, R.I.
Z. D. Hall		Lowell, Mass.
H. P. Hammett	Piedmont Manuf. Co.	Greenville, S.C.
J. F. Hanson	Bibb Manuf. Co.	Macon, Ga.
C. M. Harris, Jr.		Oakdale, Mass.
Frank Haskell	Westbrook Manuf. Co.	Saccarappa, Me.
William Hayes	Barker Mill	Auburn, Me.
Jefferson Higgins		Dodgeville, Mass.
John H. Higgins	Forestdale Manuf. Co.	Slatersville, R.I.
Charles L. Hildreth		Lowell, Mass.
J. G Hill	Lawrence Manuf. Co.	Lowell, Mass.
J. P. Hillard	American Linen Co.	Fall River, Mass.
Reuben M. Hobbs	Evansville Manuf. Co.	Evansville, Ind.
John Holland	Cocheco Manuf. Co.	Dover, N.H.
Stephen Holman		Holyoke, Mass.
George W. Holt, Jr.	Monohansett Manuf. Co.	Putnam, Conn.
John Hopkinson	Mississippi Mills	Wesson, Miss.
Elisha H. Howard	Harris Manuf. Co.	Providence, R.I.
Henry S. Howe	Pepperell & Laconia Cos.	Biddeford, Me.
W. H. Jennings	Merchants' Manuf. Co.	Fall River, Mass.
David L. Jewell	China, Webs'r & Pemb'ke M.	Suncook, N.H.
D. W. Johnson	Monadnock Mills	Claremont, N.H.
D. J. Johnston	Harmony Mills	Cohoes, N.Y.
Russell L. Jones	Ascutney Mills	Windsor, Vt.
Royal Kalloch	Tennessee Manuf. Co.	Nashville, Tenn.
Roland R. Kelly	Wampanoag Mills	Fall River, Mass.
Joseph H. Kendrick		Providence, R.I.
Hervey Kent	Exeter Manuf. Co.	Exeter, N.H.
John Kilburn	Lawrence Manuf. Co.	Lowell, Mass.
H. C. Kimball	Blackstone Manuf. Co.	Blackstone, Mass.
Richard Kitson		Lowell, Mass.
Joseph H. Knowles	Acushnet Mills,	New Bedford, Mass.
Ira F. Lawry	Whittenton Manuf. Co.	Taunton, Mass.
Frederick A. Leigh		Boston, Mass.

Thomas I. Leiper . .	Irving & Leiper Manuf. Co. .	Chester, Penn.
J. Ivers Lewis . . .	Uncasville Manuf. Co. . . .	New London, Conn.
Charles W. Lippitt .	Social Manuf. Co.	Providence, R I.
Henry Lippitt . . .	Social Manuf. Co.	Providence, R.I.
Henry F. Lippitt . .	Globe Mill	Woonsocket, R I.
Thos. L. Livermore .	. . . . .	Boston, Mass.
Robert W. Lord . .	. . . . .	Kennebunk, Me.
Charles L. Lovering .	Whittenton Manuf. Co. . . .	Taunton, Mass.
Henry M. Lovering .	Whittenton Manuf. Co. . . .	Taunton, Mass.
William C. Lovering,	Whittenton Manuf. Co. . . .	Taunton, Mass.
Augustus Lowell . .	Boott Cotton Mills	Boston, Mass.
J. S. Ludlam . . .	Merrimack Manuf. Co. . . .	Lowell, Mass.
Alvin S. Lyon . . .	Lowell Manuf. Co.	Lowell, Mass.
W. H. Magee . . .	Berkeley Mill	Ashton, R.I.
Albert T. Mansfield .	Allendale Mills	Allendale, R.I.
Albert G. Martin . .	Exposition Cotton Mills . .	Atlanta, Ga.
Rufus A. Maxfield .	Nashua Manuf. Co.	Nashua, N.H.
Thomas Mayor . .	. . . . .	Providence, R.I.
Robert McArthur . .	Grosvenor Dale Co.	No. Grosvenor Dale, Conn.
W. E. McCoy . . .	Riverside Mills	Augusta, Ga.
Charles D. McDuffie .	Manchester Mills	Manchester, N.H.
Fred. C. McDuffie .	Everett Mills	Lawrence, Mass.
James H. McMullan,	. . . . .	Biddeford, Me.
Timothy Merrick . .	Merrick Thread Co.	Holyoke, Mass.
Oliver H. Moulton .	Hamilton Manuf. Co. . . .	Lowell, Mass.
J. Turner Morehead .	. . . . .	Leaksville, N.C.
W. H. Munroe . . .	Thistle Mills	Ilchester, Md.
A. F. Nagle	. . . . .	Chicago, Ill.
Charles Nourse . .	Social Manuf. Co.	Woonsocket, R.I.
Franklin Nourse . .	York Manuf. Co.	Saco, Me.
E. H. Nutting . . .	Hooksett Manuf. Co.	Hooksett, N.H.
George H. Nye . .	Laurel Mills	Laurel, Md.
John Oldfield . . .	P. O. Box 516	Medford, Mass.
Warren M. Oswell .	Shirley Yarn Co.	Shirley, Mass.
John C. Palfrey . .	Manchester Mills, ...	Boston, Mass.
Francis J. Parker . .	Monadnock Mills	Boston, Mass.
Walter E. Parker . .	Pacific Mills	Lawrence, Mass.
John H. Parks . . .	New Brunswick Cotton Mills,	St. John, N.B.

Theophilus Parsons	Lyman Mills	Boston, Mass.
William D. Pennell	Lincoln Mill	Lewiston, Me.
Haven C. Perham		Lowell, Mass.
John M. Pevey		Lowell, Mass.
Moses Pierce	Norwich Bleachery	Norwich, Conn.
Thomas F. Plunkett	Union Manuf. Co.	N. Manchester, Ct.
H. L. Pratt	Canada Cotton Manuf. Co.	Cornwall, Ont.
Thomas Pray, Jr.	P. O. Box 2519	New York City.
J E. Prest	Wampanoag Mills	Fall River, Mass.
A. M. Pulsifer	Barker Mill	Auburn, Me.
J. M. Pusey	Delaware Mills	Wilmington, Del.
T. G. Ramsdell	Monument Mills	Housatonic, Mass.
Robert Redford	Arlington Mills	Lawrence, Mass.
James Renfrew, Jr.	Renfrew Manuf. Co.	Adams, Mass.
Roscoe C. Reynolds		Lewiston, Me.
John Rhodes		Millbury, Mass.
F. H. Rice		W. Boylston, Mass.
Howard Richmond	Crompton Co.	Providence, R.I.
A. Robeson	Fall River Print Works	Brookline, Mass.
William F. Salmon	Lowell Hosiery Co.	Lowell, Mass
H. Saltonstall	Pacific Mills	Boston, Mass.
Wm. G. Saltonstall	York Manuf. Co.	Boston, Mass.
Eugene H. Sampson,	Everett Mills	Boston, Mass.
Arnold B. Sanford	Globe Yarn Mill	Fall River, Mass.
Benjamin Saunders	Harbor Manuf. Co.	Nashua, N.H.
J. H. Sawyer	Newmarket Manuf. Co.	Boston, Mass.
John Scott	Willimantic Linen Co.	Willimantic, Conn.
John C. Sharp, Jr.	Canoe River Mills	Taunton, Mass.
E. M. Shaw	Great Falls Manuf. Co.	Great Falls, N.H.
Thomas S. Shaw	Suffolk Mills	Lowell, Mass.
Thomas C. Sheldon	Sawyer Mill	Boylston, Mass.
George E. Sherman	Peabody Mills	Newburyport, Mass.
Charles M. Shove	Granite Mills	Fall River, Mass.
George H. Simmons		Ansonia, Conn.
James B. Siner		Lawrence, Mass.
A. C. Slater	Linwood Mills	Whitinsville, Mass.
Robert R. Smith	Greenwoods Co.	New Hartford, Ct.
S. S. Spencer	Conestoga Steam Mills	Lancaster, Penn.
Wilbur A. Stiles	Victoria Mills	Newburyport, Mass.
J. M. Stone		N. Andover, Mass.
Joseph Stone	Pacific Mills	Lawrence, Mass.
Henry D. Sullivan	Naumkeag S. Cotton Co.	Salem, Mass.

George P. Taylor	Lancaster Mills	Clinton, Mass.
Richard Thackeray	Weetamoe Mills	Fall River, Mass.
E. A. Thissell		Lowell, Mass.
Charles E. Thomas	Clinton Manuf. Co.	Woonsocket, R.I.
Edwin R. Thomas	Clinton Manuf. Co.	Woonsocket, R.I.
E. W. Thomas	Tremont and Suffolk Mills	Lowell, Mass.
William E. Trainer	Linwood Mills	Linwood Sta., Pa.
C. H. Truesdell		Central Village, Ct.
Edmund E. Truesdell,	China, Webs'r & Pemb'ke M.	Suncook, N.H.
Albert F. Upton		Boston, Mass.
James Waring	Narragansett Mills	Fall River, Mass.
John Waterman	Warren Manuf. Co.	Warren, R I.
J. W. Wattles		Canton, Mass.
T. B. Wattles	Chicopee Manuf. Co.	Chicopee Falls, Ms.
George W. Weeks	Lancaster Mills	Clinton, Mass.
Henry F. West	Washington Manuf. Co.	Gloucester, N.J.
Channing Whitaker	Mass. Institute Technology	Boston, Mass.
W. J. Whitehead	V. Hudon Cotton Manuf. Co.	Hochelaga, P.Q.
Charles E. Whitin	Whitin Manuf. Co.	Whitinsville, Mass.
Charles P. Whitin	Whitinsville Cotton Mills	Whitinsville, Mass.
Harry T. Whitin	Rockdale Mill	Northbridge, Mass.
William H. Whitin	Whitin Manuf. Co.	Whitinsville, Mass.
A. N. Whiting	Whiting Mills	Oakdale, Mass.
William S. Whitney	Pocasset Manuf. Co.	Fall River, Mass.
Eben Wilbur	Indiana Cotton Mills	Cannelton, Ind.
Theoph. W. Wilmarth,		New Orleans, La.
Thomas Wilmarth	Saunders' Cotton Mills	Saundersville, Mass.
A. L. Williston	Greenville Manuf. Co.	Northampton, Mass.
George Wood	Millville Manuf. Co.	Philadelphia, Penn.
William B. Wood	Continental Mills	Boston, Mass.
C. J. H. Woodbury		Boston, Mass.
Daniel Wright	Appleton Co.	Lowell, Mass.

Total number of Honorary Members 2
Total number of Active Members, ... 223

CALL FOR MEETING.

NEW ENGLAND COTTON MANUFACTURERS' ASSOCIATION,
BOSTON, April 18, 1885.

DEAR SIR, — The stated Annual Meeting of the Association will be held at the MASSACHUSETTS INSTITUTE OF TECHNOLOGY, Boylston Street, Boston, on WEDNESDAY, April 29, 1885, at 10 o'clock, A.M., for the choice of officers for the ensuing year, and the transaction of such other business as may properly come before it.

An Afternoon session will be held, beginning at 2 o'clock.

By invitation of the Board of Government, the following matters will be presented for consideration by the speakers named below, and by other members:

Mr. T. T. ABBOT of Easthampton, Mass., will explain his new process of SPINNING COTTON DIRECTLY FROM THE DRAWING.

Mr. WILLIAM H. BENT of Taunton, Mass., will exhibit and explain a new Self-adjusting Bolster for Mule-Spindles.

Mr. WILBUR A. STILES of Newburyport, Mass., will give an account of some experiments in testing various cards.

Mr. GEORGE C. GILMORE of Manchester, N. H., has been invited to submit a record of certain tests made by him to ascertain the loss in various lots of Cotton, from the Bale to the Finisher, Picker and Lap.

Mr. CHANNING WHITAKER of Lowell, Mass., will give a statement of some tests on the RELATION OF POWER TO SPEED, IN HIGH-SPEED RING SPINNING.

Several members will present facts and figures relating to the EFFICIENCY AND ECONOMY OF THE ELECTRIC LIGHT IN COTTON MILLS.

Mr. EDWARD ATKINSON will address the Association upon the subject of the NECESSARY RELATIONS OF LABOR AND CAPITAL.

By order of the Board of Government,

AMBROSE EASTMAN,
Secretary.

PROCEEDINGS.

PURSUANT to the foregoing notice, the Annual Meeting of the New England Cotton Manufacturers' Association was held at the Massachusetts Institute of Technology, April 29, 1885, at 10 o'clock A. M., more than one hundred members being in attendance.

The President, Mr. WILLIAM C. LOVERING, occupied the chair, and, after calling to order, requested the Secretary to read the call for the meeting.

The call was read by the Secretary.

It was voted to dispense with the reading of the records.

The PRESIDENT. The first business under the call is the election of officers for the ensuing year. How shall your officers be selected? It has been the custom to appoint a committee on nominations. Is it your pleasure that a committee be appointed to nominate officers?

It was voted that a committee, consisting of three, be appointed by the Chair to nominate officers for the ensuing year, and Messrs. HERVEY KENT, ROBERT MCARTHUR and J. S. DAVIS were appointed said committee.

The PRESIDENT. I wish to say, as the time has come for the election of a new President, that I must positively decline a re-nomination, and I beg you to waste no time, but proceed immediately to the election of a new man. I believe in the infusion of new blood. I know that the interests of the Association demand it; for it is no small undertaking to direct a meeting of this kind, and I am sure some new man at the helm is needed. I therefore hope that the committee will present the name of a new candidate for President.

The Secretary and Treasurer read his report, together with the Auditor's Report, which were accepted and ordered to be placed on file.

The following gentlemen were then admitted to membership in the Association, upon recommendation of the Board of Government, to whom each nomination had been referred: —

W. R. Burnham, Superintendent Uncasville Manufacturing Company, Norwich, Conn.

Richard Thackeray, Superintendent Weetamoe Mills, Fall River, Mass.

H. C. Atwood, Superintendent Williamsville Manufacturing Company, Killingly, Conn.

The President. While the Committee on Nominations are out, it may be in order for the delegates to the New Orleans Exposition to make a report. It is very brief. The number of the Committee who were able to attend the Exposition was very small, and the amount of work done correspondingly small.

REPORT OF THE COMMITTEE APPOINTED TO VISIT THE WORLD'S COTTON EXPOSITION AT NEW ORLEANS.

By your vote the board was directed to appoint a committee to visit the World's Cotton Exposition at New Orleans. A large committee was duly appointed, but for various reasons the gentlemen selected were unable to respond, and it was found impossible to secure a committee who could make the visitation in a body or in any considerable force.

Early in March, Mr. George W. Weeks and your President undertook the duty of that committee and proceeded to New Orleans.

They were received with courtesy by the Director-General, Mr. Burke, Mr. Morehead, and other officers of the Exposition, and every facility was afforded them to see and examine everything of interest in the enormous collection from all parts of the world.

Without presuming to question the wisdom of those who inaugurated the enterprise, it is only stating what is an open secret to say that the Exposition falls far short of the anticipations of its projectors, especially in the attendance and money receipts. Financially it is a failure, but viewed in its educational aspect, its advantages, especially to the Southern section of the country, cannot be overestimated. It was planned on too gigantic a scale and was too inaccessibly located to command adequate support from the limited population within easy attending distance.

Situated five miles out from the city of New Orleans, and approachable only by small one-horse cars, or steamboats running at long and irregular intervals, the Exhibition could hardly expect a liberal patronage.

The wonderful energy, however, which conceived and executed the plans for this great Exposition cannot but challenge our admiration, and certain it is that any one making the journey to New Orleans from any part of our country will find himself amply rewarded.

To convey some idea of the grand scale upon which it is planned, it is only necessary to say that the main building covers in area very nearly double that of the main building at the Centennial in 1876.

The area covered by all the buildings erected by the management equals the entire exhibiting area covered by all the buildings erected at Philadelphia by the Centennial Commission, United States government, foreign governments, states and territories.

The steam-power for the Exhibition is the largest ever collected, being about 6,000 horse-power.

It required 1,900 horse-power, or about as much as the entire power at Philadelphia, to drive the various electric lights.

That part of the Exposition most interesting to your Committee was the exhibit of cotton, cotton machinery and cotton textiles.

Various cotton gins invited attention, but few showed any marked improvements over those exhibited at the Atlanta Exposition in 1881.

The Rollstone Combination Roller and Saw Gin claimed great advantages over its competitors in quality and quantity of work of which it was capable, but the class of cotton used in this, as in nearly all the experiments, was a long-staple free-seed cotton. This machine did good work, but your Committee cannot say that it did not injure the fibre somewhat.

A novel gin was exhibited for ginning long-staple black-seed cotton, that turned out an almost perfect fibre. It was an improved Roller Gin of extremely simple construction, and although the machine exhibited was the only one ever made, still your Committee thought it embodied features that may

make it the coming gin. It has not yet, however, been put to the severest test.

With these exceptions, the improvements in gins consisted chiefly in simplifying the feed and delivery; thereby increasing the quantity of work which a machine could turn out in a given time at the minimum cost for labor. Indeed, this seemed to be the point aimed at in all gin improvements. Any device which could increase the capacity and minimize the cost was deemed an improvement, and seemed to be the end sought. The character of the work performed seemed of secondary consideration.

Among the exhibits of cotton machinery, those of F. A. Leigh, Geo. Draper and Whitin & Co. occupied prominent positions.

The exhibits of F. A. Leigh comprised a most complete set of machinery in all the departments, from the picker to the loom, and in almost every machine some novel improvements or new point of excellence was discovered.

The Willimantic Thread Company exhibited the complete process of making spool thread, and afforded one of the most attractive features of the Exhibition.

There was a display of textile products from every mill in the South and from many Northern mills.

In the Government Department, which, by the way, was most creditable and complete, the Smithsonian Institute had on exhibition specimens of cotton and woollen fabrics from nearly all the principal mills in the country.

Cottons of various seeds and growth were exhibited in the bale, showing a high state of cultivation and preparation.

The competition for prizes among cotton exhibitors was sharp and earnest.

In the interchange of thought and intercourse of association between the different sections of our country the value of such an Exhibition is incalculable, and deserves our heartiest and fullest sympathy and patronage.

The committee on nomination of officers reported as follows: —

For President — RICHARD GARSED.

For Vice-Presidents — J. S. LUDLAM and WALTER E. PARKER.

For Directors — RUFUS A. MAXFIELD, GEORGE W. WEEKS, HENRY S. HOWE, RICHARD B. BORDEN, O. S. BROWN, HENRY F. LIPPITT.

The report of the committee was accepted, and, on motion, the Secretary was authorized to cast one ballot for the officers nominated, and the Chair declared the names presented by the nominating committee duly elected as officers of the Association for the ensuing year.

In the temporary absence of the President and Vice-Presidents elect, on motion of Mr. ATKINSON, Mr. LOVERING, the retiring President, was requested to act as chairman of the meeting.

The PRESIDENT. The first topic in the call is an explanation by Mr. T. T. ABBOT, of Easthampton, Mass., of his new process of spinning cotton directly from the drawing.

Mr. ABBOT not responding to the call, Mr. WILLIAM H. BENT, of Taunton, Mass., exhibited and explained a new self-adjusting bolster for mule spindles. His paper was as follows: —

IMPROVED BOLSTER AND RAIL FOR MULE SPINNING.

BY WILLIAM H. BENT.

I think you will agree with me that there has been no period in the history of cotton manufacturing in this country when it has been so difficult to make money in the business as it has been during the past few years.

In the great struggle to obtain a profit, manufacturers have labored diligently to reduce the cost of their goods to the lowest possible point. As the cost of the raw material is, for the most part, governed by circumstances beyond their control, their efforts at reduction must be mainly in the direction of economy of labor, power, general expenses and maintenance of plant.

One way to reduce the cost of goods is to increase the product of the machinery; and this has been done to a large extent. When the producing power of a certain plant can be increased, without materially increasing the cost of labor and without extraordinary wear and tear of the machinery, a clear gain has been made by the manufacturer so doing, as compared with his neighbor, who makes no such increase and sells his goods in the same market. The first and easiest step towards an increase of the producing capacity of a mill is to increase the speed of the machinery. How far this can be done profitably is an open question; there is a point of speed of every machine where the cost per pound of product is at its minimum, and any increase of speed beyond that point is a source of loss rather than gain.

In determining this question, the elements of cost to be considered are the labor of operatives, power consumed, repairs and depreciation of machinery by wear and tear thereof; while

it is equally important to consider the effect of an increased speed upon the quality of the product. For instance, the product of a carding-room may be increased and its cost per pound decreased very largely; but in so doing, the quality of the product may be so much impaired as to cause a very great decrease of product and increase of cost in the spinning and weaving rooms.

A good manufacturer can do much to increase the product, decrease the cost and improve the quality of his goods, by judicious management of his mill as it stands; but he must depend largely upon the builder of machinery to furnish him such improvements from time to time as will enable him to accomplish results which would be impossible with his unimproved machinery.

Every one who has been familiar with cotton manufacturing during the past ten or fifteen years will admit that much of the great advance that has been made in this art has been due to the inventions of American machinists, whose interests are so closely allied to those of the cotton manufacturer.

Improvements follow each other in quick succession, and the cotton manufacturer has to give much of his time to the study of the various new devices which are presented to his notice. Oftentimes the so-called improvements prove worthless, and his time seems to have been misspent, but this investigation is all in the right direction and not without its advantages. On the other hand, much that is valuable is brought to his notice and he gladly adopts it. With this apology, I ask your indulgence and attention while I present what now promises to be a valuable improvement in mule spinning.

To meet the demands of the times, the speed of mule has been increased, together with the other machinery. In spinning what are generally known as fine counts, the limit of the production of the mule is the limit of speed at which the spindle will run without vibration. To attain higher speed, spindles have been made of superior quality, until they are as nearly perfect as can be produced with the material and facilities within reach.

And still there is a demand for greater speed than even these improved spindles will stand. To meet this demand, the spindle being practically as good as can be made, the only thing to be done is to improve the bearings in which the spindle is run.

Heretofore all mule spindles have had their bearings in metal bolsters, which were pressed into wooden rails; or the bolsters have been cast as parts of a metal rail; the rails in both cases being attached to a wooden carriage. It has been found very difficult, if not practically impossible, to bore out the holes for the spindles in the bolsters with such accuracy as to avoid deviations one from the other; consequently the spindles would not stand in proper alignment and would bear unequally against the interior of the bolsters at top or bottom. And when the metal rail with the bolsters as part thereof is used, the whole construction is stiff and rigid, rendering vibration more liable. Then again, the carriage, to which the rails are attached, being necessarily made of wood, is liable to warp and twist out of shape, thus throwing the spindles out of line with their bearings.

In order to overcome these difficulties, this so-called "flexible bolster" and rail has been produced, after much study and experimenting, and the results of its use surpass all expectations.

It is a flexible bolster, inasmuch as it can adapt itself to the position of the spindle, but it is not, strictly speaking, a loose bolster, because it cannot move bodily laterally, nor revolve with the spindle, nor be raised by the rotation of the spindle.

The construction consists of an iron rail made in two parts, with brass bolsters, which are permitted to rock or tip upon the rail as a fulcrum, and are held in place by a spring-rod of iron wire, which is clamped between the two parts of the rail, the clamping part of the rail having projections or lugs to bear upon this wire at points between the bolsters.

The flange or web of the main part of the rail has openings to receive the bolsters; these openings are intersected by the

wire rod, so that it bears upon the bolsters to hold them in place against longitudinal or vertical movement in the rail; and the pressure of this wire rod, as it bears upon the bolsters, can be regulated by the clamping screws.

The outside diameter of the bolsters is materially less than the inside diameter of the holes in the rail that receive them. At the point where the bolster bears upon the rail it is made somewhat spherical, i. e., it is curved or rounded, so as to permit the bolster to tip or rock upon the flange as its fulcrum. There is a little space grooved out of the bolster, above and below this curved part, so as to permit the tipping of the bolster; and the direction of the spindle-band-pull is such as to bring each bolster up against its fulcrum, on which it rocks as the position of the spindle demands.

This arrangement of bolster and rail can be applied to old mules, either Mason's or the English.

Its chief advantages are: —

First. A much higher spindle-speed than can be attained with a rigid or non-adjustable bolster, all other things being the same; and therefore a large increase of the product of yarn, in all cases where the limit of speed of the mule is fixed by the speed attainable by the spindle, which is the case in making most all yarns above No. 30.

Second. A saving in power. Owing to the flexibility of the bolster, there is much less friction from the spindle and consequently less consumption of power. By preventing vibration of spindle much power is saved, as that is a great consumer of power.

Third. A saving in time and labor of oiling. In spinning fine counts, the spindles have to be stopped to be oiled during the spinning of a set of cops. This flexible bolster uses much less oil and would require less stopping and less oiling.

Fourth. Saving in cost of repairs. Owing to the freedom of the spindle and bolster, there is much less friction, therefore much less wear to both. And, whenever it becomes necessary to replace a spindle or a bolster, for any cause, both

can be removed in an instant without the use of any tools. In this connection, one element of convenience and saving of repairs is, that a crooked spindle will run without vibration in this bolster, which would be useless in a rigid bolster. In the case of the wooden bolster rail, which is much used, the replacing of worn bolsters generally involves putting in a new rail. In the case of a metal rail, with the bolster as a part thereof, of course a new rail is necessary when the bolster needs replacing. But in this arrangement of rail and bolster the rail is permanent and lasting, and a new bolster can be put in by the spinner whenever it may become necessary.

Fifth. Its application to old mules will improve them greatly at a comparatively small expense. As spindles wear, it becomes necessary to put in new ones, in order to keep the speed of the mule up to a paying point; in doing this, it is generally found that the bolsters are worn, so as to be condemned, and new ones must be put in. This bolster and rail can be applied to mules whose spindles are not perfect, but which will run well in it, and the cost will be less probably than the new spindles alone, while the results will be better.

In summing up these advantages, it appears that this improvement is one that will increase the product of the mule-spinning room; that the cost of labor per pound of product will be decreased by its use; that the cost of repairs will be reduced; that there will be less wear and tear to the mule; that the improvement is a simple one, free from complications, and that its application to old mules is comparatively inexpensive.

It would seem, therefore, that it is worthy the attention of manufacturers and may prove to be of value to all who are using mules. It is with this object in view that it has been presented to this Association, and any further information upon the matter will be cheerfully given.

Mr. ATHERTON. In the absence of Mr. ABBOT I will make a statement, although I am not authorized to speak for him, of the results of some tests that we have made at the Everett Mills on a spinning frame which was changed over to embody Mr. ABBOT's improvement.

The first test represented on the blackboard at the top, on the left, was made from roving. That was the regular process in the mill. The next test was made from railway drawing. The next was made from the second drawing on a drawing frame. The top test on the right was made from a sliver that we obtained from the Victoria Mills. We sent the card to Mr. Stiles to experiment with, and that is the result of the test on a single sliver from the card. The sliver weighed fifty-one grains and was taken right from the card to the spinning frame. The test underneath that and the last one on the right, was made from a sliver taken from a common card at the Everett Mills and put right on the spinner. The two at the right, with no doubling at all, were single slivers direct from the card, and that is the result.

The PRESIDENT. Does any gentleman desire to ask any questions?

A MEMBER. Do those figures represent the breaking strength of the yarn?

Mr. ATHERTON. Yes, sir. That is one-half of the skein.

A MEMBER. What was the number of the yarn?

Mr. ATHERTON. The numbers of the yarn were 11 and 12. The 12 was a little light, but we couldn't get from the common card a sliver from the finisher that would make No. 11 yarn. It should be No. 11 yarn, but we could not get it heavy enough for that. The samples of the yarn made from those different slivers are on the table.

Mr. LEIGH. The system of spinning directly from the drawing is not new. Over thirty years ago I saw it tried. About that time I saw three machines which were intended to revolutionize the then existing system of spinning. One was intended to make the very coarsest yarn, No. 5. Another machine was intended to make No. 10. The third machine

was intended to make No. 20 into No. 40. The first machine was to spin directly from the card. The card had twelve spindles in front, and was of the ordinary construction, 48 inches wide. The spindles were placed four inches apart, and the doffer was covered with rings of card clothing three and three-quarters inches wide and had a traverse of half an inch to clear the spaces on the cylinder.

The twelve slivers were stripped from the doffer by a comb in the ordinary way. They then passed through twelve revolving tubes to consolidate them, and so on through three pairs of drawing rolls, on to the spindles in front. The greatest disadvantage was that the production of the 12 spindles was only about one third that of the card, therefore the expense of the machinery was greater than in the ordinary way. Then there were other difficulties. The ends would have to be broken down when the card was stripped and ground, and there was considerable irregularity in the yarn, when laps were changed, etc.

The next machine was to spin the cotton direct from the drawing. That machine was made with one row of spindles set four inches apart, and three rows of cans of the ordinary size (nine inches in diameter, I think), and it had six rows of rolls. It would spin about No. 10 yarn, but the difficulties attending it more than overcame any advantage that was gained. For instance, the machinery took up three times the room of the ordinary spinning frame, in consequence of the necessity of having only one row of spindles and space for the cans at the back.

The next machine I saw was a machine to take No. 20 yarn and lengthen it to No. 40. The way that was done was this: A bobbin of No. 20 yarn was put in the creel and the thread passed through one pair of rolls, then through a revolving tube and then through two pairs of rolls. The object of the tube was partially to untwist the twist in the No. 20 to enable the rolls to draw it out. Then it went through the spinning frame, was drawn, and the extra twist put in and it came out No. 40. Well, I need not spend any time in telling you the result.

But to refer to the system of spinning from the drawing, we all know that the more we shorten up our machinery in the card room the worse we fare; at least, that is my experience. And then, if you could spin from the drawing, what advantage would it be? In the first place, your spinning would cost more and you would have more expense in drawing. If you use small cans, you must have a great number of them. I don't think you would get much more in small cans placed on top of the spinning frame than you could on a well filled bobbin. Then, again, the difficulty of storing the cans would be very great. They would have to be kept "this side up with care," and would require a great deal of room; and when you consider that the cost of slubbing, intermediate and roving frames and bobbins is only about 35 per cent. of the entire cost of the spinning frames on the ordinary plan of spinning, you will have to add in this case the extra cost of these cans and extra drawing rolls which will be about as much.

As to the quality, I do not see how it is possible to make as good quality of yarn as with the ordinary process. The reasons of failure of the three machines I have mentioned were: In the card, because the spindles could not take care of the product of the card; in the spinning direct from the drawing, because the machinery was too expensive and the room required too great; and in the machine to reduce No. 20 into No. 40, because the work was inferior and the expense greater.

I mention this because I remember the thing very well. My father was asked to examine those machines and was intending to help bring them out, but when everything was taken into consideration, that was the final result of it. In our own mill we have had what we used to call "slubbing-drawing"; that is, making slubbing in the can. It was considered at the time to be an advantage, but it was finally abandoned. That was supposed to be a step in the same direction. We got our slubbing in a small can, about six inches in diameter. When we re-arranged our card room, we took it out and put in the ordinary drawing and slubbing. So far as that operation went it was a failure.

The PRESIDENT. I would like to ask if the numbers on these bobbins correspond to the different tests placed on the blackboard?

Mr. ATHERTON. No, they do not. No. 1 marked on those bobbins is made from a common card; No. 2, from the second drawing, and No. 3 is from roving made in the mill by the regular process; No. 4 is from the Atherton card.

In reply to Mr. Leigh, I will say that the frames now running at the Everett Mills remove all the objections to which he refers. He says that the machines to which he has alluded were failures; these are a success. The cans are only 16 inches in length and about 5 inches in diameter. One of those cans of No. 28 yarn will run about eight days, so that I do not think they have to be removed very often, and the test of a frame, so far as success is concerned, is in the yarn that is made. All persons are permitted to go through the Everett Mill and see the operation, and I have never seen a person who saw those machines running who has not admitted that they have overcome all the obstacles that have heretofore presented themselves in spinning directly from the drawing.

A MEMBER. How is the frame made and how does it operate?

Mr. ATHERTON. I can explain it to the gentleman. We have three sets of rolls, two rolls in a set; we have condensing tubes, three sets or four sets, three between the different pairs of rolls, and one small one between the two front rolls, and it is simply a drawing between the rolls. The condensing trumpets are nothing new; they are open-mouthed trumpets; but it is from the small condensing tube between the two front rolls that we get the best result, and that we claim is new. The process of condensing with tubes between the rolls has been tried on drawing frames, but never on a spinning frame. The sliver is in cans, as I said, about 16 inches deep and 5 inches in diameter. They are put on shelves that are placed on the creel stands and do not increase the width of the frame. The frames are as easily tended as the other frames,

the front rolls run with the same speed as the other frames, and the direction is the same. The yarn is better than the yarn made in the new process drawing.

A MEMBER. I would like to ask Mr. Atherton the ground of his statement that this is a success. Has there been any of the yarn made in this way woven?

Mr. ATHERTON. We are not weaving now. The other yarn will weave and I do not see why this should not. I am considering the product as yarn. That is why I say it is a success. It is a success as compared with the other yarn from the same mill.

A MEMBER. What is the object of this machine? Is it the production of a better quality of yarn, or what do you gain by this process?

Mr. ATHERTON. We gain better yarn and cheaper production. We dispense with all the roving machinery entirely. The question is whether we cannot dispense with the drawing machinery in a short time.

A MEMBER. Is No. 12 as fine yarn as is made from it?

Mr. ATHERTON. No, sir. We have spun No. 93, so far at Easthampton, not at the Everett Mills.

Mr. JOHNSTON. There is an old saying and a very true one, that "History repeats itself," and while I have been listening to this discussion some of my father's early experience in a mill came to mind. I should judge from the discussion that has taken place here for the last year or two, and also from certain experiments which are being made, that the endeavor is to make yarn and cloth without machinery, and without labor. How much can we gain by it? We had been trying to make yarn by using the roving frames and dispensing with the drawing. Now, we have got down to the point, at this meeting, of dispensing with drawing, with roving, and making yarn directly from the card. Well, the point to which I wish to refer in connection with my remark about history repeating itself is, that my father tells about going to a mill seventy-two years ago, as a boy, first to sweep and then to tend what was

called a spinning billy. There they had no drawing frames, no roving frames, and very imperfect spinning machines. I understand that they made very good No. 7 to No. 10 yarn; and the best part of it is, that the man who made the yarn and made the goods got rich. The card made the roving in small rolls; probably there are some gentlemen here who have seen, in waste and other coarse material, the roving made in that way, and then end by end placed on the top of the spinning machine, drawn out and spun into yarn. As I understand, this machine which was in use seventy years ago was doing this very same thing. Those rolls were rolled out from the card and then taken by small boys and placed up on the top of the spinning machine and drawn out, twisted and spun, and the cops made from No. 7 to No. 10 yarn. Now, we are going back, in doing away with drawing and roving, to the practice of seventy years ago. We are going back so very fast, that perhaps we shall get rid of all our machinery, and then we shall get back to hand labor. We are very willing to do that, if you will only show us that we can make money by it. This yarn looks very well, but the question is whether it was made as stock is ordinarily prepared in a mill. We find that in experiments we take a little more care than we can take in the regular running. The cards are looked after a little better, the spinning is examined a little more closely; things are arranged a little more nicely, than in the general running of a mill they can be. Although that yarn may seem to be strong, I should judge from the feel of it that there is more twist than we would like to put into regular yarn. I do not know that that is so, but it feels as if there is more twist in it than we would like for our ordinary work; but if that can be worked out and yarn can be produced of superior quality, there may be something in it.

Mr. Atherton. I do not know but I am usurping the place of Mr. Abbot, but I will state that we made the conditions of those frames exactly the same as that of the other frames in the same mill.

Mr. PRAY. This is the same old inquiry over again, but will Mr. Atherton tell me how the elasticity compares in a given case between the ordinary process and the improved?

Mr. ATHERTON. I do not know just what the amount of elasticity is, but it is considerably more before it will break.

Mr. EDWARD ATKINSON. The principle of this method can be found in little southern mills where the so-called Clement attachment is introduced, attached to the back side of a common card. In front of that card the sliver is condensed one into four, drawn, and delivered into cans, and taken from the cans directly to the spinning-frame. Very fairly strong and even yarn is made in that way, but it requires a great deal more labor than the ordinary methods. The principal place in which this new and revolutionary method is being applied is in Africa, to displace hand-spinning and the hand loom. The Liberian Colonization Society, or whatever it may be called, are having these machines made to introduce into Africa.

Mr. ATHERTON. I do not want to take up the time, but I will state that Mr. Abbot, who I supposed would be here, has made a number of tests with regard to the saving in room, power, help, and everything of that kind. I do not know what the amount of saving is, but it is considerable, — sufficient to recommend it to a great many parties with whom I have talked.

Mr. WEST. I believe that the nearer we can get the fibres parallel with each other, the stronger the yarn will be. It seems to me that by taking the cotton directly from the card and spinning it into yarn, you have very little chance of getting your fibres parallel. We do that by the process of drawing, as you all know, and I am unable yet to see what we are going to gain by the process that is represented on the board. If the fibres are all mixed and tumbled up together, the yarn certainly cannot be as strong as it would be if they were all parallel, as you very well know; and in order to get them parallel, we have got to go through more than the process represented on the blackboard.

Mr. ATHERTON. We go through with just exactly as many processes as in the ordinary frame. We have three sets of rolls on one drawing-frame, instead of one set on three frames; consequently there is no difference there. The drawing is exactly the same. Some gentlemen say they do not see how the yarn can be as strong as yarn made in the ordinary way, but the test shows that it is.

Mr. LEIGH. My remarks were intended rather to give a history of what has been done, so far as my knowledge goes, than to criticise the machines under consideration, and I have tried to show that I am disinterested. I should like to ask Mr. Atherton what he expects to gain by spinning cotton from the drawing: Whether he expects to economize in first cost of machinery, in the help, or in room? I do not see that he can economize in either of those directions. In the first place, I think his spinning machine would cost more (with the cans) than the ordinary spinning machines, with all the intermediate frames and bobbins. In the next place I think the labor would be quite as much, if not more, because the cans are of so small a diameter that a great number of them will be required (two cans to each spindle) to have the necessary spares ones. They would occupy a great deal of room, they could not be handled as easily as bobbins, and as I said before, they would have to be kept "this side up with care." Now I do not believe we can get any better yarn, and we do not want to get any more of it, because the limit of production of yarn is governed by the speed of the rolls and the spindles. Therefore we have got to the end of that, so we cannot economize in that direction, nor in the cost of machinery, the room it occupies or the labor it requires. And when we remember that the present state of perfection of cotton machinery has taxed the ingenuity of the whole world for the last hundred years, we shall see that it requires something very ingenious and complex to improve the present methods. It is easy to make a change, but very difficult to make an improvement.

Mr. GEORGE DRAPER. I have been to see the operation of this method of spinning at Easthampton. I was there a lim-

ited time, and I think, to say the least, it is an interesting process. It brings us back nearer to the first principles of spinning than anything that I have ever seen, and that is the way in which more people are spinning cotton than any other; that is, to pull the cotton off and twist it into a thread by the fingers. I have never seen that operation performed, except in a certain part of Italy, and that was another fibre, I think. But the old way of spinning cotton, as I understand it, and their way of spinning, as I saw them spin, was to take the material and pull it out with their fingers and immediately twist it into thread. This thing comes the nearest to it of anything in the manufacturing line I have ever seen. They card it and make it into drawing, and then immediately draw it down from the size to which the drawing has brought it. It is all done at one operation, practically.

It seems to me that the one great question in this matter is as to whether drawing from a fibre already twisted — which has a tendency to draw from the centre — is any advantage over drawing from untwisted roving. That, I know, is considered to be a great advantage over what is called the Taunton roving and the Clipper-Speeder roving, where you simply condense without twisting it. I know it was claimed, when we made the change and adopted the plan of twisting roving, which has become almost universal, if not quite, that when we drew something that was twisted, it had a tendency to draw from the centre, and we could make a very even thread. Now, this process, when we come to the final test of the thing, must depend upon this question: What is the quality of the yarn compared with some others? You may speculate as to whether you can make as good yarn or not, but the question is, What does it make? If it has any different qualities, what are the qualities? It seems to me that the yarn which has been passed round here, — at any rate, the yarn on the particular bobbin I saw, while it is as even as a great deal of the yarn that is made, and is even enough for certain purposes, — where you are going to require the finest thread, for instance, — where

you want to make thread for the smallest sized needle, and where it is important that it should be quite strong, smooth and even, — it does not seem to me that this process is going to answer the purpose.

Now, there is another fact to be taken into consideration. I should question very much whether the new process, as they show it there, without any change, was any advantage. If you have got to doff it from the drawing-frames once in two minutes, break it off and make that additional number of pieces and make that additional number of drawings, it must be injurious, as it seems to me. If their plan is going to be adopted, they do not want to put it into small cans, but put it into larger ones, do away with piecing and follow the logic of their convictions.

There is another process with which I am acquainted, in a mill where they are making coarse yarn, — No. 6, 8 or 10, or what not. They take cotton waste, spinner's waste and card waste, to a certain extent, and run it through a double system of cards. In the second system they have a knife or something which divides it, I think, into four slivers on the card. Those slivers run into a can through a coil, and they put those slivers up to a roving machine, and they take the bobbins from the roving machine and put them immediately on the spinning-frame or the mule. You see that here is a single process of roving without any drawing; there is the drawing without the roving frame. So far as this is concerned, I have been to the mill, where this operation is carried on, a great many times; I had a slight interest in it, and I have always been astonished at this fact. I don't believe that the roving frames in the average mills that do good work run very much more steadily or with less trouble from the ends breaking down, and all that sort of thing, than they do in that mill. I have been perfectly astonished. It is a wonder to me, every time I go into it, how well that work runs.

Now, I believe that they will find the interposition of at least one roving machine, putting roving on to large bobbins, far bet-

ter than cutting them up into this small quantity which they put into a can, and breaking it from the drawing-frame once in two minutes, as I was told they did in the mill there. I do not criticise this process, either for or against it, at all; I believe in trying to learn the truth. So far as the operation of the mill is, concerned, at the time I saw it, they were running on coarse work. It seems to me it is a question largely of the cost of labor, machinery, etc., that is necessary to get cotton from the card into yarn. As far as I have been able to figure it over, taking the cost of labor, machinery and everything into account, I cannot see any great amount to be saved by it. I may be mistaken, but that is the view I take of the matter.

Mr. ATHERTON. Just one word. Mr. Draper spoke about the cans filling so quickly, in about two minutes, at the drawing-frame, and he makes an objection to that. As I stated before, one of those cans, when filled, runs about eight days, so that that is the only piecing there is. I think that will compare favorably with piecing up slubber roving.

Mr. JOHN KILBURN. It seems to me that the figures on the board show this result conclusively, that this spinning directly from the card is a step backward. The yarn made from the Atherton card averages about 10½ and breaks somewhere from sixty to sixty-five pounds; that made from the drawing breaks at about seventy pounds; that made from the roving breaks at about seventy-five pounds. It tells its own story. I don't think it needs any argument.

Mr. ATHERTON. I don't know how Mr. Kilburn calculates. I think if he strikes an average there, he will not find that that made from the roving breaks at 75, if I know anything about figures.

The PRESIDENT. The next topic is an account of some experiments in testing cards, by Mr. WILBUR A. STILES, of Newburyport, Mass. Is Mr. Stiles present?

Mr. STILES. I have been disappointed in getting the number of cards which I expected. There was only one, the "Atherton," delivered, and I have been unable to run it but two days; therefore I am not prepared to state anything further than this, that we have started one card and it is doing all we could expect. If I succeed in getting the cards, I shall continue the experiments for my own information, and if any gentlemen of the Association should care to know the results, perhaps at some future time I shall be able to give them to you.

The PRESIDENT. Mr. GEORGE C. GILMORE, of Manchester, N. H., has been invited to submit a record of certain tests made by him to ascertain the loss in various lots of cotton, from the bale to the finisher, picker and lap. Is Mr. Gilmore prepared to present his record?

Mr. GILMORE. I wish to say that if I consulted my own convenience I should be pleased to be excused to-day, as I have a very painful eye and have had for a week, but perhaps I can give a slight insight into it.

To many of your members I need not say that I had been in and around a cotton mill for thirty-five years, and also a member of this Association nearly ten.

Some eight years ago I prepared a paper from actual tests of the loss in Hoops, Sacking and Sand, in 1,830 bales of cotton, representing 28,530 used, to read before this Association. On submitting it to my superior, stating my intention, he, with a merry twinkle in his eye, said he thought the time for relating our experiences in manufacturing was after we were both out of it; and that period having now arrived, in conversation with my friend Mr. Sawyer in regard to it, and through him and by invitation of your board of managers, is my apology for appearing before you. This is the identical paper above referred to.

Loss in 1,830 bales of cotton, representing 28,530 used, including hoops and sacking, the cotton being weighed at the end of the second pickers: —

Average pounds of Hoops per bale, . . .	7.77
" " Sacking per bale, . . .	12.91
Per cent. of loss, per bale, Hoops, . . .	1.69
Sacking, . . .	2.81
Sand, ...	10.28
Total, ...	14.78
Leaving net cotton, ...	85.22

In 1866, when I first became responsible for the running of a cotton mill, using 30 to 40 bales per week, I thought the loss from cotton to cloth altogether too much. Then began investigation all along the line, with not much success, until reaching the raw material, being the grades usually used in making coarse brown sheetings and drills. Run four bales, after making arrangements to collect all the sand, with the following result: —

1. Bale, 138 pounds of sand, seeds etc.
2. " 121 " " "
3. " 141 " " "
4. " 183 " " "

Then changed to weighing the cotton, ten bales from each invoice, also the hoops and sacking, keeping a complete record of the amount of each; but for some time averaged each bale as weighing 460 pounds, and for a short period at 500, but in all, from this time out, took invoices or actual weights. In 1872 I went as Superintendent where we used more than 300 bales per week, using three grades of cotton, and there continued my investigations in some large invoices. We tried 20, 30 or even 40 bales, but averaged them and made the record as only ten. The following will show the result of the best test made of a large invoice: —

Per cent. of Hoops,	. . . . .	1.34
" " Sacking,	. . . . .	2.34
" " Sand,	. . . . .	2.78
" " Cotton,	. . . . .	93.54
		100.00

And this one the greatest loss in any large invoice; but have tried single bales with a much greater loss: —

Per cent. of Hoops,	. . . . .	1.40
" " Sacking,	. . . . .	2.31
" " Sand,	. . . . .	32.38
" " Cotton,	. . . . .	63.91
		100.00

Perhaps you may ask me the relative costs of the above lots. As that was entirely out of my line, I never gave it but a passing consideration, but recollect one instance where a certain lot cost $\frac{7}{8}$ of a cent less than another. Was requested to find what the actual was, by the difference in tests, and did so. Instead of $\frac{7}{8}$ of a cent it should have been *three* cents less.

I made up the loss of Hoops, Sacking and Sand, for seven successive six months, to compare with the actual waste.

Hoops, Sacking and Sand,	first six months, . .	14.70
" " "	second six months, .	15.94
" " "	third six months, . .	13.75
" " "	fourth six months, .	14.70
" " "	fifth six months, . .	13.76
" " "	sixth six months, . .	12.47
" " "	seventh six months, .	13.10

The last record is as follows: 264 invoices of 10 bales each, making 2,640 actually tested, and representing that used to the amount of 41,184 bales, being 156 to each invoice: —

Average pounds Hoops per bale, ...	7.71
" " Sacking per bale, . . .	12.80
Per cent. of Hoops, ...	1.54
" " Sacking, ...	2.56
" " Sand, ...	10.61
" " Cotton, ...	85.29
	100.00

Of the ten best invoices of the above, or 1,560 bales, as follows: —

Loss on Hoops, Sacking and Sand, ...	8.23
Deduct average Hoops and Sacking, . . .	4.10
making	4.13

per cent. loss, as against 10.61, the average.

The PRESIDENT. The next subject announced in the notice of the meeting is the relation of power to speed in high-speed ring spinning. I understand that Mr. Channing Whitaker, of Lowell, Mass., who was expected to state some tests made by him in connection with this matter is not present, and we will therefore proceed to the subject of electric light in cotton mills, and ask for facts and figures in relation to the efficiency of that light. I will call first upon Col. LIVERMORE, of Manchester, N. H.

Col. LIVERMORE. At the meeting of the Association in October, 1882, I gave some of the results of the use, in the Amoskeag Mills, of the Brush arc lights for several months in 1882. Those results were printed in the proceedings of the Association at that time, and it is unnecessary, on that account, to repeat them in detail. But I may say that I then arrived at the conclusion that an electric light running for four hours a day replaced gas at a cost of $1 25 per thousand feet. In

other words, that gas, to do the same work at the same cost, would have to be furnished at $1.25 a thousand. Since that time, owing to the decreased cost of the carbons used in the lamps, to the increased efficiency of the lamps, and to the results of experience, the cost has been reduced, so that to-day it is considerably less.

In reckoning the cost of electric light, I have first taken the actual cost of the carbons consumed in the lamps, then the actual cost of the repairs expended upon the machines, lamps and wire,—the whole electric plant,—and the actual cost of labor. Then I have taken what I believe to be the actual cost of steam power for the number of hours run, and have allowed ten per cent. for wear and depreciation on machine and lamps — ten per cent. of the cost of the electric plant for the actual hours run. Of course interest should be allowed on the cost of the electric light, and interest runs all the time, whether the lamps are running or not; therefore the interest of a day should be charged to the electric light, whether it is run one hour or five hours in the day. And it seems to me fair also to charge the interest of the steam plant required to run the electric light upon the same basis; that is, to charge the interest for a day whether the lamps run by the steam power, run for the whole or any part of the day.

During the last year I have run 160 Weston arc lights in one mill. The results as to the length of time which a carbon will last, and as to the hours of the day in which lamps are run I think will be about the same in all the mills, but I have had an accurate account kept in this one mill, which is of modern construction, about 470 feet long and 100 feet wide, of four stories; the two lower stories have weaving, the next one carding, and the upper one spinning. I have had a record kept of the number of hours which the light was run in each of these rooms, the number of carbons used, and the expense, so that I think this report is as accurate as we may expect to get from a large cotton mill.

In this mill for the year ending February, 1885, I used 22,825 carbons. The cost of those carbons has varied from time to time; at present they can be got for a little less than 3 cents apiece; in large lots, for about 2½ cents apiece, and I have given the cost of carbons at 2½ cents. We have used in this mill, as I say, 22.825 carbons. We find that we get 7.14 hours of light per lamp from one carbon. We have used to light 44,000 spindles and spoolers for the same, on 44,920 square feet of floor, 26 lamps. The average use of those lamps on this floor has been 1.14 hours per day. For lighting the card-room, which has an annex, making 62,000 feet of floor space in all, and containing 377 cards and the roving machinery appertaining to them, we have used 14 lamps. The average hours burned per day was 1.17. For lighting 800 box looms belted from below, on 44,920 feet of floor space, we have used 50 lamps; average hours of burning, 3.32 per day. For lighting 800 box looms belted from above we have used 70 lamps; average hours of burning, 5.15. These lamps are on the lower floor, which is necessarily darker than that above, the belting from above necessarily interfering somewhat with the electric light, so that it takes more lamps than it does on the floor above. The average use of all the lamps in the mill is 3.68 hours per day. The average number of gas burners displaced by each lamp was 13.7. We used a gas light over each loom, and I have reckoned the number of gas burners displaced in the weaving room upon that basis. In the carding rooms I have reckoned that the number of gas lights displaced is equal to those which are actually used in the other carding-room, and likewise in the spinning-room. I estimate that the consumption of the gas burners which we would have used would be four feet per hour. They are what are called four-feet burners, although tests through the mill show that in some cases they consume as high as 4.9 feet an hour and in some cases as low as 2.2 feet an hour. The quantity consumed of course varies with the regulation which is put upon the gas, with the obstructions in the pipe and the pressure in the main. If they do not use

four feet an hour they ought to, to give the requisite light, and therefore it is fair to assume that a gas burner when compared with the electric light should be reckoned at four feet an hour.

The cost of the carbons, labor and repairs, per lamp per hour, was 1.63 cents; in 1882 it was 2.89 cents. The cost of steam-power per hour, without interest, reckoning one horse power per lamp and reckoning a horse power worth $50 per annum, and charging each lamp with 3.68 hours per day use of power, is 1.44 cents per hour. Wear and depreciation of the electric plant, at 10 per cent. on $150 a light, which is a fair sum, I think, to take as the cost of an Arc light to-day, is 4.7 mills per hour. It was the same in 1882. That makes the cost, without interest, 3.54 cents per hour for the electric light in 1885. In 1882 it was 4.8 cents. The interest on steam and electric plant, assuming a horse power to cost $45, is 4.29 cts. a day.

An electric light displaces 13.7 gas burners. In 3.68 hours, which was the average use of electric lamps, a lamp would equal 50.40 gas burners. The gas consumed by 50.40 burners in an hour would be 201.6 feet. The cost of displacing those 201.6 feet is found to be, by the method which I have detailed, 17.2 cents. 201.6 feet of gas necessary to displace an electric light, at 17.2 cents, equals 85 cents per thousand feet.

Mr. Henry F. Lippitt. Mr. Chairman and Gentlemen: At the previous discussion of this matter, some two years ago, I gave an account of the result of the incandescent electric light as it had been used in the Globe Mill. At that time we had 117 incandescent lamps in use, and we thought they made a saving of about 50 per cent. over gas at $2.20 per thousand feet, which would be equivalent to $1.10 per thousand, and that they made a saving of about 31 per cent. over oil gas such as we used at the Social Mill. Those lights were in use in the weaving-room alone. They have been continued in use since that time, and give us good satisfaction. We have no fault to find with them in any way. The manner of running them is the same as it was at that time; and I do not

know that I have anything that I can add to what was said in regard to them then.

Since that time we have started our Nourse Mill, which we light entirely with electric light, using the United States Company's Maxim light and their improved machines, by which they are enabled to produce about nine and a half lamps to a horse power as compared with some four and a half or five lamps on the machines in use at the Globe Mill. In the Nourse Mill, where we are making fine goods, that is, goods made out of fine yarns and of high count, we have been anxious to get a bright light; so that we have put the incandescent lamps very much closer than in the Globe Mill. We have also lit the spinning and other departments in addition to the weaving, where of course the incandescent light does not displace as many gas lights as in the weaving department. We are very well satisfied with the way the light works. We get an admirable light. It is free from flicker, from the danger of fire, and from other troubles which we have with gas light, so that we think that it is a great improvement upon it.

I have made up a statement of the cost of electricity as compared with the Globe Mill when we were using gas alone, at $2.20 a thousand feet, and with the Social Mill, which is lighted entirely by oil gas. In making these figures I have taken the interest at ten per cent. upon the cost of the plant. That is, the plant in the case of the oil gas is the apparatus for making the gas and the piping through the mill; in the case of the town gas, it is merely the piping in the mill; and in the case of the electric light, it is the machines, the wiring and the lamps. I have used ten per cent. in figuring the interest in all cases.

The total cost of lighting the Social Mill, with 54,000 spindles, using oil gas, is $2,557. The total cost of lighting the Globe Mill, with 41,000 spindles, using town gas at $2.20 per thousand feet, is $2,782. The total cost of lighting the Nourse Mill, with 26,000 spindles, with incandescent electric light, is $2,238. In other words, it has cost us for oil gas $47.35 per

thousand spindles; for town gas, $67.85 per thousand spindles; and for electricity, $86.08 per thousand spindles, per year. You will see that we are paying about twice as much for electric light at the Nourse Mill as we are for the oil gas at the Social Mill, and about one-half more than we would pay at the Globe Mill for town gas, providing we were using that alone. But that is by no means a fair statement of the comparative cost of gas and the electric light. We are using so much larger quantity of light where we are using electricity that the cost must necessarily be more; and if we take the number of burners that we should probably need at the Nourse Mills to get the same amount of light that we now get by electricity, as nearly as I can figure it, we should save about thirty per cent. over gas by using the electric light.

In making up the cost of the electric light, the interest on the plant is very much the largest part of the entire cost. We are burning 583 lights there, and the plant cost us $10,479 as it stands. That includes the first cost of the machines, the cost of transportation, the cost of making the accommodations for them at the mill; the belting, and in fact every cent that was spent before the machines were started. The cost of the electric light alone for that mill is $1,738 for the year. I give as the entire cost of lighting the mill $2,238. We find that we are obliged to use a small quantity of gas. The electric machines are driven entirely by the main engine, and we are obliged to use gas before the engine starts in the morning, and at night after the engine has stopped; to light the help in and out of the mill. We also use it in the machine shop, and in one or two places where they are likely to work overtime and be obliged to use light when the main engine is not running. So that we have charged about $500 for gas in that mill during the year, making the total cost for light $2,238, of which $500 is for gas and $1,738 for electricity.

Mr. Atkinson. I would like to ask Mr. Lippitt or Col. Livermore whether there is any way of measuring the better condition of the help and the effectiveness of the work under electricity as compared with gas?

Mr. LIPPITT. I have not found any way of doing it; I don't know whether there is or not; but as far as I can tell by general observation, there is no question but that the way the Nourse Mill is lighted is very much superior to the way the other mills are lighted. The light is a bright, clear, white light, and it is very easy to see the fine threads when they are broken. As most mill people know, after the mills light up the help are very much more apt to make poor work, particularly in the weaving, than during the day time, but I think with the light we have there the operatives get along as well after the mill is lighted as they do before it. I can say that the operatives all like it, the overseers like it, and generally throughout the mill it is preferred to gas light.

Col. LIVERMORE. I have never been able to find any accurate way of ascertaining the fact so as to be able to answer the question put by Mr. Atkinson, because the situation has changed so. Where we have endeavored to compare the operation of the mill under gas light, we have found that it has invariably produced more after the electric light was put in than before, but there were other causes, doubtless, tending to that result. I think it is obvious that the difference in the weaving between summer and winter, which used to be so great, has been much less since the electric light was put in. I cannot, of course, say that it is all due to the electric light, but I believe it is in a measure due to it. There is one thing, however, which shows that the condition of the help is improved by the electric light, and that is the unanimous judgment of the help on that point, for where they have not the electric light (I speak of the weavers especially) they want it.

Mr. JOHNSTON. The question of the effect upon health is one that is not often thought of. Because the operatives like it does not settle the question, because people like a good many things that are not good for them. I know a store in the city of Troy where they commenced about two years ago to use an arc light. After about six months' use it was taken out of that store. I inquired why, and the parties who tended that store said

because it affected their eyes so seriously that they could not stay there if the use of that light was continued. The air may be vitiated, and probably is, by burning gas, and yet the brain may be more injuriously affected by the strong, intense electric light. The question is which will affect the physical condition of the help most.

There is another matter in relation to economy. Of course we want to look at all the phases of it. I was in a mill last winter where they were lighting one end of a room with the incandescent light and the other end of the room was lighted with gas. When it came lighting up time, the end of the room lighted by gas was lighted nicely; the other end did not light at all. I saw some of the men running round and followed them. They went to the machine and found that for some reason, they could not tell what, the machine was running, but they did not get any light. By and by they made some little change about the machine and the light went on, but they had been fifteen or twenty minutes in the dark and considerable damage was done. So it would seem that the question is surrounded with more difficulties than we shall be likely to settle at this meeting. But the question of how it affects the eyes and brain of the help I think it would be well to look into before we all adopt the electric light.

Mr. Pray. Only last week I was called about eighty miles out of the city of New York to a mill where they are weaving very fine goods, not cotton, but high-colored fancy goods. In one end of the establishment, containing something like 400 looms, they used, during several months last winter, the arc electric light, and it became absolutely impossible for them to make their finest figured goods after the daylight had gone. From that establishment I went immediately to a hospital adjoining where there were about twenty women with various diseases of the eyes and the nerves connected with them. Some of them will probably never enjoy the vision which we enjoy to-day. It has become a very serious question wherever high colors and fine goods are required, and this matter will

without doubt be embodied in the next medical report to the State — either the surgical report or the medical report. It is not yet public property, but that came under my immediate observation only last week.

Mr. STILES. If I remember correctly, Col. Livermore stated that he charged the electric light fifty dollars per horse power. I would like to ask him if that is the actual cost or the estimated cost?

Col. LIVERMORE. It was estimated, because we are running by water power. I estimated what it would cost by steam. I would like to inquire of the last gentleman up whether he understood that those twenty people who were in the hospital were there as the result of the electric light or high colors? (Laughter.)

Mr. PRAY. The twenty people to whom I referred are now in a State hospital (which I visited in my professional capacity), from the effects of electric light. They were employed as weavers upon fine goods, which are not cotton goods, and those fine goods are woven in high colors and in figures, what those of you who are used to weaving figured goods term "set figures," and the goods are worth a great deal more than either cotton or wool. I will say that sixteen of those people have been pronounced practically blind. They may be able, perhaps, to grope their way about the street or about the house. The matter is not yet public property, and I should not have mentioned it, except that Mr. Johnston raised the question. The surgeons call it "tension of the optic nerves," caused by intense and long-continued application, under very unfavorable circumstances.

Col. LIVERMORE. I would like to ask, in all seriousness, if the gentleman knows whether there were any people in that hospital from that mill, in consequence of diseases of the eye, before the electric light was introduced?

Mr. PRAY. That I very carefully inquired about, with the board of which I was a member. Not since five or six years ago, when some very bright aniline colors were used in the

mill, when the eyes and ears both became affected by the floating particles, but the operatives were not affected at that time to any such extent as they have been by the electric light. The matter is being carefully watched now by a competent surgeon in order to ascertain whether it is as they fear or not; and efforts are being made to have a different electric light put in the same mill by another company to ascertain whether there is any difference as between the arc and incandescent systems. Of course, that experiment will take up the whole season.

Col. LIVERMORE. If that is the Arc Company, I think we may know how it will be settled.

The SECRETARY. Letters have been received from Mr. Goodale and Mr. Wattles upon the subject-matter under discussion, which I will now read.

BOSTON MANUFACTURING CO.,
WALTHAM, MASS., April 28, 1885.

AMBROSE EASTMAN, ESQ., *Secretary:*

DEAR SIR, — In response to your inquiry regarding the economy and efficiency of the electric light at this mill, would say: It has been in use one year. The average life of each lamp has been 825 hours. Charging renewals at $1 a lamp, with a liberal estimate for power, attendance, supplies, and 10 per cent. added for interest and depreciation, the cost is equal to gas at 90 cents per thousand. The light gives no trouble, and is perfectly satisfactory. System — Weston Incandescent.

Yours truly,

A. M. GOODALE, *Agent.*

CHICOPEE MANUFACTURING COMPANY,
CHICOPEE FALLS, MASS., April 27, 1885.

AMBROSE EASTMAN, ESQ., *Secretary:*

DEAR SIR, — Circumstances over which I have no control prevent my being present at the meeting of the Manufacturers' Association the 29th inst. Below find statement of what we are doing with the electric light.

We are running one No. 7 Brush Machine, with 45 lamps of (so-called) 1,200 C.P. each.

Cost of machine, lamps, etc., say $4,500.

Cost for carbons for 45 lamps, 20 cents per hour.

Cost for oil and attendance for time run, 40 cents per hour.

Each lamp furnishes a good light for 32 36-inch looms, or a floor space of say 1,680 square feet. Height of room, 15 feet.

Estimated power required for 45 lamps, 25 H.P.

As we run by water, I reckon the total cost of the 45 lamps at 60 cents per hour, aside from the interest on the investment.

Yours truly,

T. B. WATTLES.

Mr. C. I. BARKER. I have been very much interested in what has been said in reference to the electric light, and very much interested in the estimates which Col. Livermore has made with regard to the cost of running the electric light. We have at the Bates Mill one room containing six hundred looms running on colored work, which is lit with the Arc light. We have had them in operation now three years, and I must say that the light is very satisfactory in every respect. From the time they were put in down to the present time they have never failed to shed their light when wanted, when in repair, and never but once has anything happened to our plant to prevent our having the light at the time we called for it. As regards the eyesight, from the best judgment I have in the matter, and from all the information that I have got from the help, I think it is very much less hurtful to the eyes than gas. For instance, last winter the cylinder of one of our machines gave out and I had to send it to New York, which stopped the electric light on seventeen lamps. It was gone nearly a week, and before that machine got back it was a question whether we could keep the weavers in that part of the room or not. We have a gas light over each loom, which seems to give a good light, but the difference was so great between the electric light and the gas, with fourteen looms to a lamp, that we had, as I said, hard work to keep our weavers there until the machine came back. It seems to me that weavers should know their own feelings as well as anybody else.

"During all the experiments made by me at Lonsdale I paid especial attention to the general condition of the frame with respect to cleaning and oiling, and to see that the work was being properly done; to the setting of the spindles, examining them while running with the bobbins off, to see that they ran true as well as satisfying myself that they ran freely in their bearings; to the selection of the bobbins; to the adjustment of the bands; the arrangement of the traverse; the weighting of the rolls; the connection of the dynamometer with the frame; and in general to all points which could affect the power required as well as to some which could not."

By the courtesy of Messrs George Draper & Sons, at whose requests the tests were made, I am enabled to present below the principal results of Mr. Southworth's tests of the "Modified Sawyer" and the "No. 15 Common Sawyer" spindles.

Results of Tests.

Modified Spindles.

Revolutions per Minute.		Power, foot pound, per second per Spindle.			Number of Spindles to One-horse Power.
Front Rolls.	Spindles.	Empty Bobbins.	Full Bobbins.	Mean.	
59.25	5413.	3.305	3.766	3.535	155.6
64.05	5851.	3.697	4.274	3.985	138.0
70.25	6418.	4.270	5.063	4.666	117.9
76.1	6954.	4.802	5.673	5.237	105.0
82.85	7573.	5.444	6.568	6.006	91 6
88.8	8113.	6.045	7.415	6.730	81.7
97.8	8934.	6.941	8.422	7.681	71.6

No. 15 Common Spindles.

Revolutions per Minute.		Power, foot pounds, per second per Spindle.			Number of Spindles to One-horse Power.
Front Rolls.	Spindles.	Empty Bobbins.	Full Bobbins.	Mean.	
59 2	5408.	3.140	3 675	3.407	161.4
63.95	5842.	3.536	4.139	3.837	143.3
69.9	6386.	4.025	4.933	4.479	122.8
75.85	6929.	4.659	5.655	5.157	106.7
82.5	7539.	5.338	6.537	5.937	92.6
88.9	8124.	6 034	7.331	6.682	82 3
97.95	8948.	7.009	8 419	7.714	71.3

	Weight in Ounces.	
	Modified Spindle.	No. 15 Common Spindle.
Tip of Spindle, ...	0.94	0.67
Butt of Spindle, ...	3.39	3.31
Whole of Spindle, ...	4.33	3.98
Full Bobbin, ...	2.27	2.23
Empty Bobbin, ...	0.75	0.71
Yarn, ...	1.52	1.52

These two sets of spindles were tested with seven different speeds, in the same frame, on the same day, Feb. 7, 1878. They were set in the same steps and bolsters, and were driven by the same bands. The bolsters were reamed to a loose fit. The yarn produced was number 28 warp nearly. The traverse was $5\frac{1}{8}$ inches.

The curves which exhibit the relation between the speed of the spindles and the power required to drive them, in these tests, are very regular. The regularity is due, as Mr. Southworth informs me, in part to the regularity and rapidity with which the speeds were changed, which prevented irregular changes in the spindle oil viscosity and in the band tension, and in part to the regularity and care with which the oiling of the machine was conducted, which prevented noticeable changes in the conditions of lubrication.

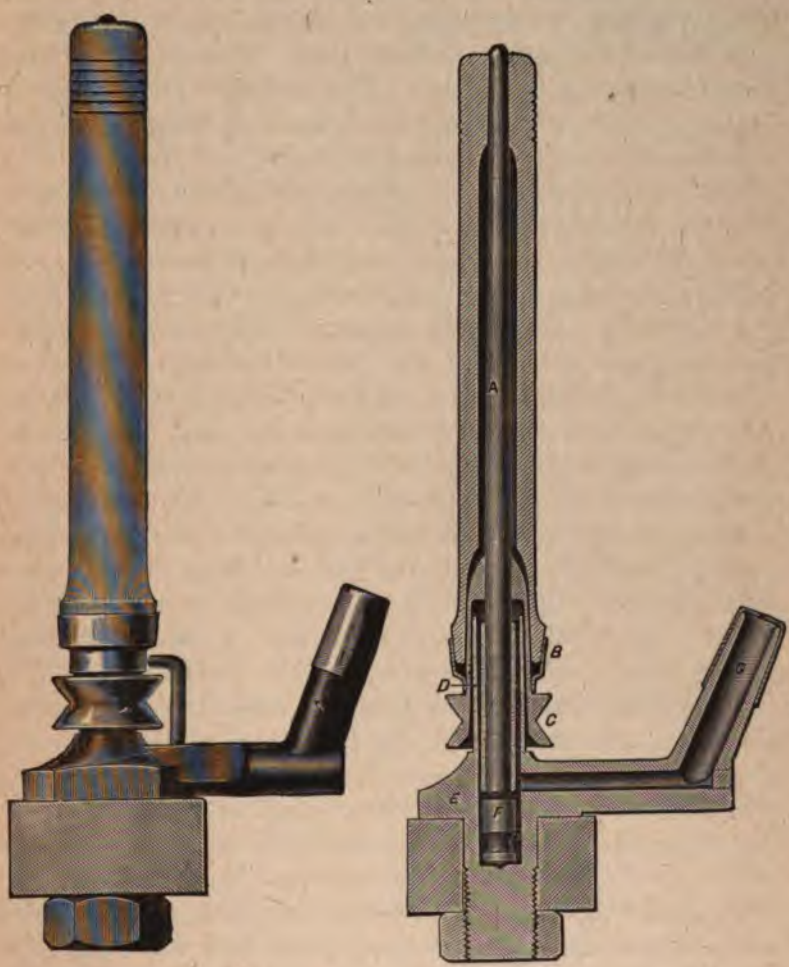
The scientific precision, and the painstaking, expert skill with which these tests were made, are very creditable to Mr. Southworth and to the enterprising firm at whose expense they were conducted.

Recent Tests. — I have recently tested two high-speed spinning frames. One of these had New Rabbeth Spindles, with Kilburn Locks, and Draper's Double Adjustable Spinning Rings. The other had Eureka Improved Spindles, with Draper's Double Adjustable Spinning Rings. The speeds of the New Rabbeth Spindles varied from 6609 to 9947 revolutions per minute in different tests. The speeds of the Eureka Spindles varied from 9593 to 9955 revolutions per minute. Both varieties of spindle ran well, and without perceptible vibration at any speed at which they were tested. Both of the frames were built by the Lowell Machine Shop. The New Rabbeth Spindles were made by Messrs. George Draper & Sons.

The New Rabbeth Spindle. — By permission of Messrs. George Draper & Sons, I extract from pp. 33 and 34 of "Improvements in Cotton Machinery, 1881," the following description of the New Rabbeth spindle: —

"The distinguishing peculiarity of this spindle, as compared with others in common use, is the fact that the foot of the spindle is not confined in the usual way, but rests upon a flat surface on which it may move laterally in any direction; and this freedom of lateral motion extends to the bolster, which is surrounded by an elastic packing, and located at the lower end of the

spindle. As a result of this arrangement the spindle runs steadily and without jar under all ordinary circumstances, finding its natural centre of rotation, even with an unbalanced



load of yarn or a slightly defective bobbin, very much as a top will when spun with such velocity that it 'goes to sleep.' In the case of the spindle, its velocity is so enormous, and its

ordinary load is so nearly balanced, that the small amount of liberty allowed by the elasticity of the packing is sufficient for the purpose."

"In the sectional view given, A represents the spindle; B the cup, which receives the tapering lower end of the bobbin, and drives it frictionally. There is not, and should not be, an adhesive bearing at the top of the bobbin. C is the whirl, which is so located that the pull of the driving band comes opposite the middle of the bolster bearing; D, the packing of braided woollen fabric surrounding the bolster; E, the cast-iron base; F, the step, having a neck at its lower end, around which the packing is secured; and G, the oil chamber, covered by a brass thimble, and communicating directly with the packing and the bearings of the spindle. Other details are sufficiently apparent to need no explanation. The spindle is adjusted in the rail if desired, though in practice it is found easier and better to adjust the rings. In oiling, use Downer's light spindle oil, or some oil having substantially the same qualities. Sperm oil or any other animal oil will not answer."

It is claimed that this spindle "excels in its capacity for running at a speed only limited by the capacity of other parts of the frame, or by the ability of the spinner to piece up the ends"; that "other valuable advantages" are "its cleanliness"; "the length of time it will run without fresh oil"; "its perfect steadiness in running," and "its economy of power, as compared with any other spindle, except the Sawyer."

The Kilburn Lock is an interesting feature of the New Rabbeth spindles which were tested. This is the invention of Mr. John Kilburn, agent of the Lawrence Manufacturing Company of Lowell, Mass., and formerly president of this association. The Kilburn Lock is not shown in the drawing. It is a bayonet lock. It prevents the rotation of the movable bolster, and the gradual destruction, by friction, of the elastic fabric which surrounds it. The lock was placed at the top of the bolster, in the frame of New Rabbeth spindles tested, as

was the case in Mr. Kilburn's original design. As at present built by Messrs. George Draper & Sons, it is placed at the bottom of the bolster.

POWER TESTS OF A FRAME OF 192 NEW RABBETH SPINDLES.—This frame was located in the Lawrence Manufacturing Company's Mill, Number 7, and was under the supervision of Mr. J. F. Williams, overseer. The spindles were spaced two and one-half inches from centre to centre. The rings were one and five-eighths inches in diameter. A spindle with its whirl was found to weigh 1666. grains. The average weight of 192 bobbins was found to be 528.65 grains each. The front rolls had a diameter of one inch, the back rolls a diameter of seven-eighths of an inch. The centres of the back and middle rolls were one and one-fourth inches apart. The centres of the middle and front rolls were one inch apart. The front top rolls were long boss shell rolls. The middle and back rolls were solid. Weights of six and one-half pounds each were hung upon the wooden saddles, which pressed upon the top rolls. The tops of the spindles were one and seven-eighths inches below the thread guides. The thread guides were six and one-half inches from the bites of the front rolls. Doyle separators were used, as adapted for high speeds by Mr. J. F. Williams.

The Condition of the Frame. — Previous to the tests Mr. Williams was instructed by Mr. Kilburn, through the regular channels of communication, to have the machine put in good order for a test, and to be certain that none of the bands should be slack enough to make bad yarn. During the tests of April 15th, 16th and 17th, Mr. Williams had charge of oiling the frame, and was requested to oil it at the usual intervals. At the close of those tests he stated in writing substantially that the frame was in ordinary running condition; that no effort was made to cause the frame to run differently than was usual; that the spindles and shell roll were last oiled Monday, April 6th, 1885; that the draft was 8; that twelve yards from each of twenty-eight bobbins of roving were weighed by the

overseer of carding and himself, and that the roving averaged 2.66 hanks. The weight of yarn on a full bobbin was 1.688 ounces.

The Principal Results of the tests follow, arranged in the order of the speeds of the spindles: —

Date. April, 1885.	Revolutions per Minute of Spindle.	Spindles to the Horse-Power.	Relative Humidity.	Average Number.	Breaking Strength in Pounds.	Average Temperature. In the Room.	Average Temperature. Out of Doors.	Direction of the Wind.
16, P.M	6609.	132.1	28.	19.31	84.42	77.2	49.2	N. W.
17, A.M.	7039.	110.9	32.	19.52	84.00	77.5	49.8	N.
16, A.M.	7976.	99.4	29.	19 81	79.28	76.3	43.0	N. N. W.
15, P.M.	9081.	66.2	33.	19.80	81.14	75.9	51.3	N. W.
17, P.M.	9947.	62.6	31.	19.12	86.00	78.3	53.8	N. W.

Tests of the Side Pulls of the Bands. — At the conclusion of the power tests, partly on the 17th and partly on the 18th of April, the side pulls of the bands were weighed by Mr. Charles H. Fisher and myself, by the aid of a band tester, which was invented by Mr. Jacob H. Sawyer, the inventor of the Sawyer spindle. The average tension of the bands was found to be 2.6 pounds. One band weighed one-half of a pound, one weighed five-eighths of a pound, three weighed three-quarters of a pound, all others weighed one pound or more. One band weighed seven and one-quarter pounds, one weighed eight and three-quarters pounds, and two weighed nine and three eighths pounds each.

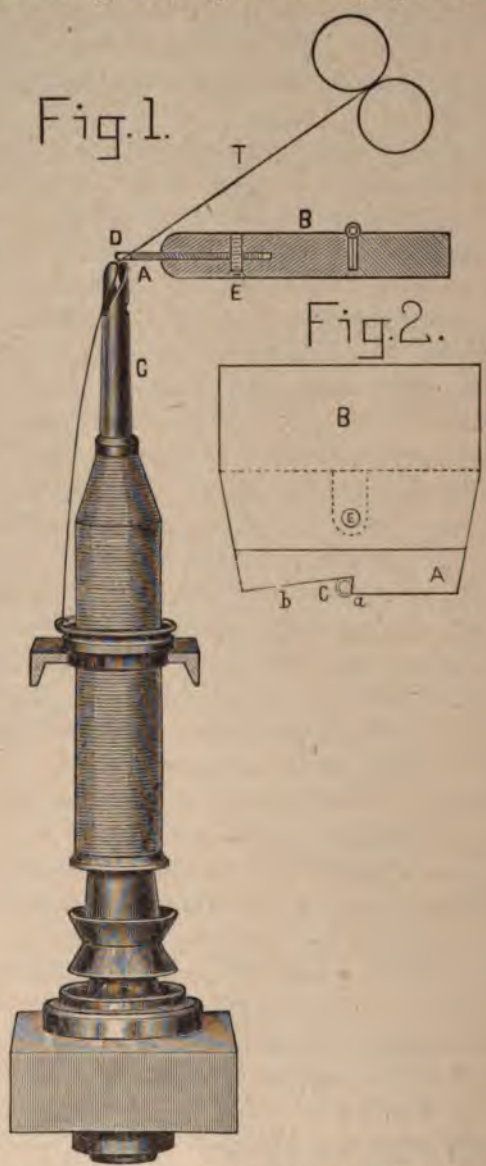
The Average Relative Humidity, while the side pulls of the bands were being weighed, was 35, as determined by Mr. Fisher.

The Tests of the Numbers and Strengths of the Yarn Spun, which was all Warp Yarn, were made by Mr. W. S. Kelley,

overseer, who is regularly employed in that service by the Lawrence Manufacturing Company, and were reported to me by Captain J. Gilbert Hill, superintendent. Careful search was made for soft and insufficiently twisted yarn, but none was found on any bobbin.

The Results of the Power Tests somewhat irregular. Side Pulls of Bands.—I had hoped to ascertain from these tests the law which should express the relation of power to speed in high-speed spinning with the new Rabbeth spindle. I found, however, less regularity than I had desired to have obtained in the corresponding changes of power and speed. I therefore consulted Mr. W. S. Southworth upon this point and learned that he had obtained extremely regular results, of the character of those sought for, only when he had been able to make his changes of speed with great rapidity, and in regular order, while filling a single set of bobbins. I also requested of Mr. Southworth his opinion as to whether a band which was so loose as to exert a side pull of but a single ½ pound when on the spindle whirl, would drive the spindle at its full speed. He replied that he had many times proved by the aid of a speed-counter fixed upon the spindle, that such a band *would* drive the spindle at its full speed. He said, in addition, that he had examined the twist of yarn which had been spun upon spindles that had been driven with such bands. He had found no lack of twist in such yarn. I then requested of Captain Hill, that such bands as exerted a side pull of more than 2 pounds on the spindle might be slackened preparatory to other tests. In the mean time, the overseer, Mr. Williams, made the test that I will now describe. He selected two bands. One of them exerted a side pull of 4 pounds, and the other a side pull of but 1 pound. He gave the yarn spun by the aid of these bands to Mr. Kelley to be examined in the usual way, but with only a number attached to each bobbin. The yarn that was spun by the aid of the slacker band was a little superior to the other, but not more so than is frequently the case when the conditions under which the spinning progresses appear to be the same. A repetition of the experiment gave, substantially, the same result.

The Eureka Improved Spindle. — By permission of Mr.



James R. Gray, treasurer of the Eureka Spindle Company of Ayer, Mass., I am enabled to present the cuts and the sub-

stance of the description of this device, which were published in the "Textile Record" for April, 1885. The object of the invention is to cause the yarn to receive its full twist and strength as quickly as it leaves the bite of the front rolls, and before the strain is applied to it of winding it upon the bobbin. In order to accomplish this result, the spindle C, Fig. 1, is extended upward through and above the bobbin nearly to the height at which the guide-wires were formerly placed. The upper portion of the spindle is a short hollow tube, terminating in the tip. The walls of this hollow tube are cut through by two diametrically opposite spiral slots. These change the hollow tube into a short spiral fork, of two prongs, in which the spindle terminates. A thread-guard, A, is attached to the finger-board B. The guard is of sheet steel and is rounded and hardened on its front edge to prevent wear. One-half of the front is cut back at *b*, forming the projecting point *a*. This guard is applied just above the spindle-tip, and is set back so that the inclined side *b* will allow the thread *t* to extend in a straight line from the bite of the front rolls to the centre of the tip of the fork of the spindle. The projecting point *a* extends forward of the tip of the fork and a little to the right of the centre.

The thread, which was not twisted when it was delivered from the bite of the rolls, lies between the two prongs of the fork and receives one twist with each rotation of the spindle. As the traveller falls behind the bobbin, while winding the yarn upon it, the traveller gradually draws the thread from between the prongs, and it falls upon the inclined side *b*, of the thread guard. It rests, but only for an instant, on the guard just back of the spindle, when it is caught by the lips of a spiral prong and laid again between the prongs of the fork. The thread slips from between the prongs as often as is necessary to prevent the thread from winding about the upper portion of the spindle, as the traveller falls behind the spindle. It is claimed for this invention that by giving the yarn its full twist as it leaves the bite of the front rolls, as is done on mules and flyer

frames, the number of breakages is less, the yarn is stronger and more even, and the operation of piecing up broken ends at very high speeds can be more easily and successfully performed.

Power Tests of a Frame of 160 Eureka Improved Spindles. — This frame is located in the Merrimack Manufacturing Company's Mill, Number 6, and is under the charge of Mr. W. C. Welch, overseer. It was built in the summer of 1884. While being tested it was spinning filling that did not differ much from number 36, from roving that did not differ much from 4-hank roving. The draft was 9, and the twist did not differ much from 25.29. The spindles were spaced $2\frac{1}{2}$ inches from centre to centre. The rings were $1\frac{3}{8}$ inches diameter. The average weight of 160 bobbins was found to be 254.3 grains each. The front rolls had a diameter of 1 inch. The back rolls had a diameter of $\frac{7}{8}$ of an inch. The front top rolls were long boss, shell rolls. The middle and back rolls were solid. The bolsters were new, with leather steps and bushings and had been in use but three days previous to the tests. Doyle separators were used, as modified for high speeds by Mr. J. F. Williams.

The Principal Results of the tests follow, arranged in the order of the speeds of the spindles: —

Date. April, 1885.	Revolutions per Minute of Spindles.	Spindles to the Horse-Power.	Relative Humidity.	Average Number.	Average Breaking Strength in Pounds.	Average Temperatures in the Room.
22, P.M.	9593.	92 8	44.	–	–	83.8
23, A.M.	9729.	76.2	53.	–	–	79.0
28, A.M.	9851.	80.8	55.	–	–	74.3
23, P M.	9940.	91.7	50.	34.93	36.75	84.8
24, A.M.	9955.	85.1	49	35.70	35.95	83 3

Tests of the Side Pulls of the Bands.—The power test of the forenoon of April 23, was made with a speed somewhat more rapid, and with a relative humidity somewhat greater than the speed and humidity of the afternoon before. The number of spindles to the horse-power had fallen off from 92.8 to 76.2. Presuming that the increase of humidity had tightened the bands, and that the average side pull of the bands had been from the beginning several times as much as the one-half pound which had been found to be entirely sufficient, I determined to test the side pulls with the Sawyer Band Tester. This test was made, as at the Lawrence Manufacturing Company's mill, by Mr. Fisher and myself. We found the greatest side pull to be three and three-quarters pounds, the least to be one-half a pound, and the average to be two pounds. I also at the same time stretched the bands that exerted a side pull which was more than two and one-half times the sufficient side pull of one-half a pound. The average side pull, after I had stretched the bands, was 1.2 pounds each. The relative humidity, while the bands were being tested, stretched and tested again, was 50, and, during the power test which followed on the same afternoon, the relative humidity averaged the same, 50. Although the speed was still more rapid than in the morning, the revolutions per minute of the spindle reaching 9940, the reduction of the band tension had increased the number of spindles to the horse-power to 91.7, a number but slightly less than 92.8, the number of spindles to the horse-power with the slower speed of the first test of 9593 revolutions per minute. The power test of the next morning was followed by a third test of the side pull of the bands. The speed was but a trifle faster than that of the preceding afternoon. The relative humidity was a trifle less, 49, but the number of spindles to the horse-power had been noticeably reduced to 85.1. The relative humidity remained the same during the last band testing, 49. I was astonished to find by the test that the bands had, during less than twenty-four hours, entirely recovered the average side pull of the first band test of 2 pounds each.

Comparison of the Numbers, Strengths and Elasticities of Yarns spun with Tight and with Over-tight Bands. — In order to ascertain if any slack-twisted yarn had been made, during the tests of the afternoon of the 23d and the forenoon of the 24th, I requested the careful aid of Mr. John W. Smith, overseer, who is charged with the duty of testing yarn for the Merrimack Manufacturing Company. Guided by that band test which had preceded the two power tests, I selected the bobbins of yarn which, on the afternoon of April 23d, had been spun by the aid of the tightest ten bands, as well as those that had been spun by the aid of the slackest ten bands. To each bobbin I attached a tag, bearing a number which indicated only the position in the frame, of the spindle which had carried it. I also selected the yarn which, on the forenoon of the 24th, had been spun by the aid of the same twenty bands, that is, the tightest ten and the slackest ten bands. Because of a misunderstanding, five of the selected bobbins were removed by the doffers. Five others were therefore chosen in their stead.

The two sets of twenty bobbins were handed to Mr. Smith, with the request that he would select from each lot any bobbins of slack-twisted yarn that the lot might contain. No other information was given to him than that which the tags afforded. The weight of yarn on a full bobbin was .925 ounces. I give below the results of the yarn tests by Mr. Smith, in a table, side by side with the tests of the side pulls of the bands.

Number indicating the position of the Spindle.	Side Pull of the Band.			Quality of the Yarn Spun April 23d, P.M.			Quality of the Yarn Spun April 24th, A.M.		
	Before the Test of the 23d, P.M.	After the Test of the 24th, A.M.	Mean.	Number.	Strength.	Elasticity.	Number.	Strength.	Elasticity.
1	1.5	2.5	2.	33.33	40.	2.00	35.71	36.	1.75
3	1.75	2.75	2.25	37.04	35.	1.62	37.04	33.	1.62
4	1.5	2.5	2.00	37.04	35.	1.63	37.04	34.	1.63
12	.75	2.00	1.38	34.48	40.	1.87	36.36	35.	1.62
15	.75	2.00	1.38	34.48	35.	1.88	37.04	33.	1.62
17	1.25	3.25	2.25	33.33	44.	1.75	36.36	35.	1.63
36	1.5	2.00	1.75	35.71	36.	1.75	33.33	40.	1.75
50	1.5	2.5	2.00	35.09	37.	1.63	–	–	–
56	1.5	2.25	1.88	35.09	32.	1.50	–	–	–
62	1.5	2.5	2.00	32.26	41.	1.87	–	–	–
69	1.5	2.5	2.00	35.71	35.	1.63	–	–	–
83	1.25	2.25	1.75	–	–	–	35.71	37.	1.75
86	.75	2.25	1.5	34.48	35.	1.62	33.33	44.	1.75
89	1.25	2.5	1.88	–	–	–	37.04	30.	1.50
95	.75	1.25	1.00	–	–	–	35.71	34.	1.62
96	1.25	1.5	1.38	–	–	–	33.33	42.	1.75
100	.75	1.00	.88	37.04	32.	1.50	38.46	30.	1.50
107	.75	1.00	.88	34.48	37.	1.63	33.89	40.	1 75
109	.75	1.00	.88	36.36	32.	1.50	35.09	38.	1.75
113	1.25	2.5	1.88	32.78	42.	1.87	37.73	30.	1.50
118	.5	1.5	1.00	34.48	40.	1.75	33.33	40.	1.75
121	.5	1.75	1.13	33.33	36.	1.75	34.48	38.	1.63
134	.75	2.00	1.38	35.09	38.	1.75	34.48	40.	1.62
146	.5	1.00	.75	37.04	33.	1.50	–	–	–
149	1.25	1.75	1.50	–	–	–	38.46	30.	1.50
Average, . . .				34.93	36.75	1.70	35.70	35.95	1.65

In forty trials of the number, the greatest variation from the average was a little less than 9 per cent.

Mr. Smith addressed to me the following note, as a part of his report: —

Mr. Whitaker, — *Dear Sir:* The above averages are fully equal in quality to several other tests made from other patterns of guides from ten spindles on each side of the frame, where we know all of the bands were tight. During the testing I found two bobbins I thought might be slack-twisted, but

on trial with the twist counter at 5.45 this morning, when the mill was still and no air in motion, I found the twist right, but the yarn was light. I do not think there was slack-twisted yarn in the parcels tested. I give you a leaf from my testing book, which will show you the condition of the yarn on each bobbin, with the numbers of each bobbin corresponding to the numbers in your book.

Very respectfully,

JOHN W. SMITH.

P. S. The counting twist out of fine filling (white) is delicate work, and may be questioned. I use a good engraver's glass and have to make several trials on each thread.

J. W. S.

Later Power Tests of the Frame of 192 New Rabbeth Spindles. — Returning to the Lawrence Manufacturing Company's mill on the afternoon of April 24, I continued the test of the frame of 192 New Rabbeth Spindles. I had requested that such bands as had exerted a side pull upon the spindle of more than two pounds might be stretched; and I expected to find that more spindles than before would be driven per horse-power. This expectation was fully realized. The average speed of the spindles was 9131 revolutions per minute, while the number of spindles to the horse-power was 103.1. On the 15th of April, in the afternoon, with the speed of the spindles 9081 revolutions per minute, fifty less than on the afternoon of the 24th, the number of spindles to the horse-power was only 66.2. The rolls and the building mechanism were oiled by me during the test of the 24th. The gain in spindles to the horse-power was 36.9, or 55.7 per cent. In my judgment, this gain was chiefly due to the stretching of the bands. The average relative humidity, during the afternoon test of April 24, was 35. The average temperature in the room was 83.5° F. The average temperature out of doors was 82.7° F. The wind was southwest.

Unfortunately, the side pulls of the bands were not tested until the following morning. It had rained plentifully during the night, and the average relative humidity had increased from 35 to 46. The average side pull of the bands, with an average relative humidity of 46, was 2.3 pounds. How much less the average side pull was, during the power test, when the average relative humidity was only 35, cannot now be stated. These bands were now stretched until their side pulls averaged only 1.1 pounds, preparatory to a power test which was made on the afternoon of April 25. The number of revolutions per minute of the spindles was 9111 on the 25th, 20 revolutions less than on the afternoon before, and the number of spindles to the horse-power was only 92.6. The average relative humidity was 40. The average temperature in the room was 79.3° F. The average temperature out of doors was 66.5° F. The direction of the wind was north-northwest. At the conclusion of the power test, and on the same afternoon, the side pulls of the bands were again tested. The average side pull had increased to 1.6 pounds. The average relative humidity during the band test was 44. The recovery of a portion of the original side pull was not unexpected, after the similar experience with the bands of the Eureka spindles.

It will have been noticed that while the spindle speeds had varied but 20 revolutions per minute, in the tests of April 24, P.M., and April 25, P.M., the number of spindles to the horse-power had fallen off by 10.5, a loss of 10.2 per cent. The changes which had occurred in the relative humidity make the change which had been produced in the average side pull of the bands uncertain. There is, however, an evident reason why the number of spindles to the horse-power should have been less in the test of the 25th. The temperature of the room was 4.2° F. lower, during the test of the 25th. Moreover, the frame had spun steadily during the usual working hours almost until the beginning of the test of the 24th. It had been stopped for 21 hours preceding the test of the 25th.

The spindle oil was then, on the 25th, comparatively cold and viscous, and fewer spindles would be driven per horse-power.

Comparison of the Numbers, Strengths, and Excesses above Super-extra Strength, of the Yarns on different Bobbins, Spun with Tight and Over-tight Bands. — In order to ascertain if any slack-twisted yarn had been made during the afternoon of April 25, I selected the bobbins of yarn which had been spun by the aid of the tightest ten bands and also those which had been spun by the aid of the slackest ten bands. In making the selection, I was guided by the results of that band test which preceded the power test. I also put with these two other bobbins of yarn which had been selected by Mr. Williams, making 22 bobbins in all. To each bobbin I attached a tag. This bore a number which indicated only the position in the frame of the spindle which carried it. The bobbins were all delivered to Mr. W. S. Kelley, overseer, with the request that he would select any bobbins of slack-twisted yarn that might be found among them. No information was given to him excepting the number on the tag. Mr. Kelley reported to me through Captain Hill, superintendent, that there was no slack-twisted yarn in the lot.

The results of Mr. Kelley's yarn tests are given below in a table, side by side with the results of the band tests.

Number on tag indicating position of Spindle.	SIDE PULL OF BAND.				QUALITY OF THE YARN SPUN, APRIL 25, P.M.							
	Before it was Stretched.	After it was Stretched,			Breaking Strength.		Grains in one Lea.		Number.		Above Super-Extra Strength.	
		Before the test of April 25, P.M.	After the test of April 25, P.M.	Mean.	Sample 1.	Sample 2.	Sample 1.	Sample 2.	Sample 1.	Sample 2.	Sample 1.	Sample 2.
1	4.25	2.00	2.25	2.13	86.	80.	48.5	50.0	20.83	20.00	14.75	6.00
2	1.25	1.25	1.00	1.13	82.	79.	51.5	49.0	19 41	20.40	6.40	6.50
5	1.75	.75	1.25	1.00	82.	86.	48.5	50.0	20.83	20.00	10.75	12.00
12	.75	.75	1.00	.88	86.	91.	52.0	52.0	19.23	19.23	10.00	15.00
16	1.25	1.25	1.25	1.25	89.	80.	50.0	48.5	20.00	20.61	15.00	8.10
20	New.	1.00	1.25	1.13	80.	77.	47.0	47.5	21.27	21.05	10.20	6.50
22	1.00	1.00	1.25	1.13	92.	92.	54.0	54.0	18 51	18.51	14.10	14.10
30	.38	.38	.75	.56	76.	82.	50.0	51.5	20.00	19.41	2.00	6.40
47	3.75	1.25	3.00	2.13	79.	78.	50.0	49.5	20.00	20.20	5.00	4.75
59	3.00	1.25	2.00	1.63	79.	80.	49.0	50.5	20.40	19.80	6.50	5.50
60	1.25	1.25	1.00	1.13	83.	80.	51.0	50.5	19.60	19.80	7.50	5.50
62	1.00	1.00	.75	.88	80.	84.	48.0	50.0	20.83	20.00	8.75	10.00
75	1.00	1.00	1.00	1.00	93.	90.	56.0	53.0	17.85	18.86	13.25	13.25
76	2.25	.50	1.25	.88	90.	84.	49.0	51.0	20.20	19.60	16.75	8.50
84	.75	.75	.50	.63	86.	90.	48.5	49.5	20.61	20.20	14.10	16.75
95	3.50	1.00	2.75	1.88	85.	86.	51.0	50.0	19.60	20.00	9.50	12.00
98	4.00	1.25	2.00	1.63	84.	83.	48.5	51.0	20.61	19.60	12.10	7.50
101	4.50	1.00	2.00	1.50	86.	85.	48.0	49.0	20.61	20.40	14.10	12.50
103	4.00	1.25	2.50	1.88	85.	86.	51.0	49.0	19.60	20.40	9.50	13.50
106	.50	.50	1.25	.88	81.	84.	49.0	51.5	20.40	19.41	8.50	8.40
108	4 50	1.25	1.50	1.38	83.	82.	46.0	47.5	21.74	21.05	14.85	11.50
110	New.	1.00	1.75	1.38	88.	84.	50.0	49.5	20.00	20.20	14.00	10.75
Average, ...					84.32	83.77	. . .		20.10	19.94	10.80	9.73

In forty-four trials of the number, the greatest variation from the average was a little less than 11 per cent.

The Emerson Power Scale. — The power tests were made with an Emerson Cotton Mill Power Scale. The instrument is numbered 26, in the series of the manufacture. Before the power tests I had examined it critically, in comparison with a delicate Prony brake, at the speeds of 410, 602, 791 and 998 revolutions per minute, of the shaft of the power scale. The report of the results of this examination is too voluminous to be here introduced. It was published in full in the "Boston Journal of Commerce" for March 14, 1885, and may be there consulted. It is stated therein that this examination "has proven that, when the instrument is in good order and skilfully used, there are no errors in its indications that are not minute."

Comparison of the Power Scale with a more delicate Prony Brake. — I have taken advantage of the time which has elapsed between the making of the power tests and the printing of this report, to subject the power scale number 26 to still more delicate tests. The Prony brake has been made more delicate and more exact in its indications, and capable of consuming much more power than before; and that without any such fluctuation in the quantity of power consumed as required a frequent change in the adjusting screw of the brake during the progress of a comparison with the power scale. I have compared the power scale with this improved brake under conditions which include the range of my former experiments.

The Range of the Comparisons Extended. — In the tests of the Eureka spindles, the speed had been reached of 1242, and in the tests of the New Rabbeth Spindles the speed had been reached of 1421 revolutions per minute of the shaft of the power scale. I have extended the range of the comparisons so as to include speeds approximating to 1375 revolutions per minute, with net indicated forces such as were used in those power tests which were made at the highest speed. The results cannot be detailed within the limits of this report. I may, however, say that, at the highest speed, with the greatest net ndicated force, a small percentage correction is necessary to cause the indications of the power scale to correspond, abso-

lutely, with those of the Prony brake; that this correction appears to be invariable for a given speed and net indicated force; but that it becomes less and less as either the speed or the net indicated force is reduced. More precisely correct power tests can be made with this instrument than with any other transmission dynamometer that I have used, even when the small correction just referred to is disregarded. When the correction *is* made, results which approach absolute correctness can be obtained. In four such corrected tests, at an average speed of 1375 revolutions per minute, and with 95.31 foot pounds transmitted per revolution, the greatest variation from the absolute, of the corrected result, was .24 foot pound per revolution, or $\frac{1}{4}$ of one per cent.

I am indebted to several persons for courtesies extended at the mills: to Mr. John Kilburn, Agent, and to Capt. J. Gilbert Hill, Superintendent, of the Lawrence Manufacturing Company; to Mr. J. S. Ludlam, Agent, and to Mr. Edward P. Dennis, Superintendent, of the Merrimack Manufacturing Company. I am also indebted to Mr. Charles H. Fisher, formerly assistant professor of mechanical engineering at the Massachusetts Institute of Technology, whose assistance I have had in the work of the tests.

Mr. Atkinson. Before Mr. Whitaker leaves I would like to make two or three inquiries which I hope he will answer when he makes his report. I will not ask him to take the time to answer them now. In what respect does the York spindle differ from the Eaton spindle of some twenty years ago, which had a spiral?

What kind of oil had been used to lubricate the Rabbeth spindle which was out of condition? Whether it was mineral oil, which is not supposed to become viscous, or whether it was mixed oil, in which there was some animal oil?

It occurs to me, now that this subject of band tension has been brought up again, that I probably made one mistake when this matter was brought before the association at a previous meeting, that I did not patent the composite band

of linen and cotton which I then made, which stretched less than an inch, where every other kind of band stretched several inches I ought to have patented it, and I may yet do so. If I had sold the patent to Mr. Draper, a large portion of the spinners would have been using that band at the present time. [Laughter.]

Mr. WHITAKER. Concerning the Eaton spindle, to which Mr. Atkinson has referred, I know nothing whatever about it. Concerning the oil which was used on the Rabbeth spindle, I know nothing about it, except that it was very sticky when I tested it with my fingers.

Mr. ATKINSON. I thought you might, perhaps, find out, and embody it in your printed report.

On motion of Mr. LEIGH, it was voted "That the Board of government be authorized to levy an assessment not exceeding ten dollars upon the members, to meet the expenses of the ensuing year."

A recess was then taken until 2.30 P.M.

AFTERNOON SESSION.

The Association re-assembled at 2.30, Vice President PARKER in the chair.

The PRESIDENT. Gentlemen, the only subject left upon the list for to-day is a paper by Mr. Edward Atkinson on the "Necessary Relations of Labor and Capital."

Mr. KENT. Before Mr. Atkinson begins his paper, will you allow me to make a simple motion, which should have been made this morning? I move that the thanks of this association be extended to Hon. William C. Lovering, our retiring president, for the very courteous, efficient and able manner with which he has presided at the meetings of this association.

Mr. DRAPER. I most heartily second the motion, but I would suggest that the other officers during the past year be included.

The amendment was accepted and the motion carried unanimously.

THE NECESSARY RELATIONS OF LABOR AND CAPITAL.

BY EDWARD ATKINSON.

About two weeks since I happened to show to your president a small copy of one of the graphical tables which are upon this wall. Soon after this he informed me that your committee desired me to make that table a text for an address to you under the above title, and this very complimentary request I have the more gratefully accepted because I had almost concluded that I ought to forego attendance at your meetings, for fear I might at last wear out my welcome by overmuch speaking.

On so short a notice I could, of course, only cast some of the materials which I had already in hand into a little different form, and if you find that some of the facts and tables which I shall present to you are already familiar to you, from my own previous use of them, you must forego criticism because of my necessity.

I will refer at once to the table which attracted your president's attention; and here let me premise that the facts which are given in this table are not all derived from one source, therefore the results cannot be imputed to a single mill. They are, nevertheless, as accurate and as absolute as if they had been compiled from a single set of accounts.

Standard Cotton Sheetings.

The general tendency of wages toward a maximum and of profits to a minimum is shown by these diverging lines. There have been, of course, great fluctuations; but it will be observed that even the reduction in the rate of wages in money, between

1883 and 1885, was accompanied by an increase in the purchasing power of money, so that wages, measured in sheetings, are now higher than ever before. I believe this is also true, if wages are measured in food or woollens. In other words, all who are employed at all can get more for their work than ever before, in food, clothing and shelter.

In 1840 the art of cotton spinning and weaving had become very completely established in this country; its methods were the same as they are now; the standard sheeting was a well-known fabric, both here and in foreign countries; the price of cotton in 1840 was not very different from the present price: but from 1840 to 1850 it was subject to greater fluctuations than have occurred in recent years. A larger working capital was required by the manufacturer than at present, because all the goods were sold on long credits. For that reason I have considered only the fixed capital of the mills under consideration, and have computed the share of product assigned to capital only in respect to a reasonable profit on the fixed investment. Had I assigned a share of the product to the active capital in 1840 and in 1885 respectively, the disparity which will be shown in the comparison of the respective shares of profits and wages, *i. e.*, of capital and labor, would have been much greater in favor of labor.

I might almost entitle this table as one showing "how the *poor* became *richer* while the *rich* have become *poorer* in running a cotton mill," but that would not be either just or quite true. The facts are that the operatives have attained higher wages, shorter hours and better conditions of life, while the rich — if such they may be called, who own these factories — have become neither richer nor poorer, but have, on the average, enjoyed a fair income upon their capital; — the mills chosen for this example having never been subjected to any financial difficulty or to any reduction in the value of their shares. In my judgment, the operative who has deposited his savings in one of our best savings banks for the last thirty or forty years, has received a higher proportionate interest on

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his capital than has been secured by the average of cotton mill stockholders on their investment.

So far as these examples prove a rule, Progress *from* Poverty, on the part of operatives, has been continuous in this art, and has been perfectly consistent with the maintenance of the capital in the factory; which capital is unquestionably owned in part, and perhaps in largest part, by men who are now rich and who have, many of them, inherited their wealth from those who built the mills. Therefore in these cases, at least, there has been no contest between labor and capital, but both have prospered, or at some periods and in some measure, have been subjected to depression together, under a higher law which governs their relations and which is superior to any statute.

I will now explain the table which is before you. You will observe that at the head of the column on the left, all the diagonal lines diverge from a common point. These lines represent product per hand, spindles, value per hand, wages, etc. We therefore establish each element at a standard which we will call 100 in 1840 at this point, at the head of the left column, and from that we will trace the divergent lines to the points on the second vertical line, which indicate the conditions of 1883, and then to the points on the third line, which are the conditions of the present date; a moderate reduction in the rates of wages having been made in 1884.

[See Diagram opposite.]

1. The product per hand had risen from 9,600 yards per year in 1840 to 28,032 in 1883, and to 29,604 at the rate of the present production; it will be 30,000, as soon as some new machinery is fairly limbered up.

2. Without any material change in the number of dollars of fixed capital, the mills have been almost built over and the old machinery has been displaced, while new machinery has been added, resulting in a gain from 12,500 spindles in 1840 to 30,824 in 1883, and 35,720 in 1885.

3. The value of the product per hand has advanced from $868 to $1,973 in 1883, and then receded to $1,924; the price of sheeting being reduced in 1885 more than the yards of product increased, the price of cotton not being very different at either date.

4. Now let me call your attention to an apparently singular point, but one of the utmost importance in this consideration.

Suppose the operatives had been direct sharers in the actual product of sheetings at the market price in place of being paid wages in money, and you observe that although the rate of their wages in money was reduced between 1883 and 1885, yet their wages, if paid in sheetings, would have increased from 1,936 yards in 1840 to 4,097 yards in 1883, and 4,154 yards in 1885. I shall revert to this point presently.

5. The wages in cents per hour have advanced from $4\frac{49}{100}$ for the long day's work of 1840 to $8\frac{80}{100}$ for the shorter hours of 1883, and $8\frac{37}{100}$ in 1883.

6. The wages per year have advanced from $175 for 13 hours in 1840 to $287 for 11 hours in 1883, and $270 for $10\frac{3}{4}$ in 1885; but I shall presently prove to you that the lower rate in money of 1885 was really a higher wage in absolute power than the higher rate of 1883, because it would buy more and yet leave a larger saving.

7. There were many fluctuations in the number of hands between 1840 and 1883, although the numbers come out almost even. Each revolution in, and addition to, machinery required for a time a little larger force, as between 1883 and 1885, but as soon as the additional machinery came into a thorough working condition the number of operatives was reduced, as it doubtless will be again, the last changes being barely completed.

8. The hours of labor have been reduced from 13 to $10\frac{3}{4}$ average.

9. Consumers have gained the difference between 9 cents and $6\frac{1}{2}$ cents a yard.

10. Now let us see what has become of the share of capital.

In 1840 the normal rate of profit which would have sufficed to induce the extension of the business was about 10 per cent.; now it is about 6 per cent., because there is now more capital in proportion to its possible use. The proportion of the yards required to be set aside to yield 10 per cent. in 1840 and 10 per cent. in 1883 went down 49 per cent., and the proportion required to yield 6 per cent. in 1885 went down 70 per cent. as compared to 1840.

11. The proportion of the price per yard required to yield 10 per cent. on the fixed capital in 1840 was $1\frac{18}{100}$ cents, and that required to yield 6 per cent. in 1885 was $\frac{1}{4}$ of a cent.

That is to say, it was necessary to assign a little over 13 per cent. of the value of the product to fixed capital in 1840, leaving 87 per cent. of the small product for the cost of materials, supplies, insurance, taxes, general expenses *and labor*, while in 1885 less than 4 per cent. of the much larger product at the lower price suffices for a normal rate of profit on the fixed capital, and 96 per cent. is assigned to all other elements of cost, including labor.

Between these two dates there have been periods when all dividends have been suspended; other periods, during the war, of extravagant profits; at present it is again a question whether any dividend can be earned or not; but for the whole term there has been steady progress either in the rate or the purchasing power of wages, except during the war period, when, although the rate in paper substitutes for money advanced, the purchasing power declined in greater measure.

I have partly completed the analysis of a print-cloth mill, all mule spinning, by a comparison of the condition of 1871 and 1884.

It will be remembered that the year 1871 was a year of inflation, feverish activity, high prices and apparently of high wages. The currency was depreciated and the end of a financial debauch on the greenback basis had been foreseen and its necessary course of loss and depression had been predicted by the few but had not become apparent to the many.

In the mill there was no change in the number of spindles between the two dates, but other improvements made each hand more effective; the yards of product per hand went up from 26,531 yards, representing 3,382 hours' work in 1871, to 32,391 yards, representing 2,695 hours' work in 1884 — an increase of 22 per cent. in product, and a decrease of 20 per cent. in hours of labor.

The wages per hand per hour were $12\frac{45}{100}$ cents in 1871, and $12\frac{03}{100}$ cents in 1884; decrease 3.37 per cent.

The wages per year were $\$421\frac{25}{100}$ in 1871 in a fluctuating paper currency, and $\$324\frac{33}{100}$ in 1884 in gold, a nominal decrease of 23 per cent.

The price of printing-cloth averaged $6\frac{789}{1000}$ cents in 1871, and only $3\frac{331}{1000}$ in 1884 — a decrease of $50\frac{94}{100}$ per cent.

At these prices the wages of the operatives converted into yards of their own product would have yielded them 6,205 yards in 1871, and in 1884, 9,737 — an increase of $56\frac{92}{100}$ per cent.

I have been unable to get exact data for 1871 on other points, but in a general way it may be safely assumed that the proportion of the lower rate of wages of 1884 suitable to be assigned to clothing, would have purchased not only more prints, but more worsted and woollen goods than the same proportion of the higher rates of 1871.

In the course of my railroad investigations, I have elsewhere proved that the prices of beef, pork, wheat, flour, oats, butter, lard, cheese and wool fell more than 25 per cent. between 1871 and 1884, and are now still lower.

It is, therefore, certain that $\$324\frac{33}{100}$ would buy more clothing and food in 1884 than $\$421\frac{25}{100}$ would purchase in 1871, and unless the town where this mill is, differs from other towns, the proportionate reduction in the price of shelter has been more than equal to the proportionate reduction in the rate of wages.

It will be observed that the average earnings per hand in this mill were more than in the standard sheeting mill; this is

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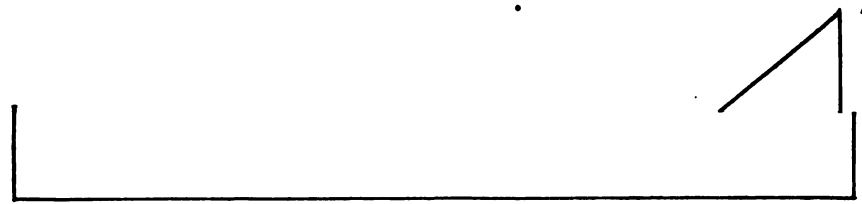
Pig Iron

Diagram showing the changes which have occurred in a blast furnace used for the conversion of iron ores and coal purchased at market prices, into pig iron.

The conditions of 1861 @ 1864 inc. 5 years are taken as a standard, each being called 100 and all represented by the single point at the head of the column on the left: from which point the lines of variation diverge, and the several points in the column on the right show the result of such variations in product, price & at the average of 1875 @ 1879 inc. 5 years.



Product per hand increased
776 tons to 1219 tons

Compiled from data furnished by Joseph D Weeks of Pittsburg, by Edw Atkinson - Boston April 1885.

because the adult mule spinner does more work per man than the frame spinner does per woman or girl.

I doubt not there were periods during the malignant era of paper money, when prices and profits advanced more rapidly than wages and when high rates of wages in paper yielded a poor subsistence, but I have not yet succeeded in making a comparison between two dates in which the condition of the laborer who was in continuous employment did not improve. That is to say, either the wages of the workman advanced faster than the cost of subsistence, or else when wages were reduced the cost of subsistence was also reduced in greater measure.

The hardship in times of depression and of reduction in prices falls on two classes: —

1. On the manufacturers or merchants who carry the stocks of material or of finished goods.

2. On the laborers who are either wholly thrown out of employment by the cessation of work in certain directions or who throw themselves out of work because they are dissatisfied with the rates of wages.

Fortunately by far the greater portion of the work of production and distribution must go on whatever the "times" so called, may be, whether good or bad, and the actual suffering in modern days is limited to a very small portion of the community in point of number. In this matter the commercial crises of modern times, which are usually caused by what is very absurdly termed "over production," are much less injurious than those of former periods which were caused by scarcity.

[See Diagram opposite.]

I now call your attention to the second diagram relating to pig iron. These figures are from the books of an iron furnace for which all the materials were purchased. It relates wholly to the art of converting ore and coal into pig iron.

The two periods compared are 1860 to 1864, inclusive, a period of war, paper money, inflation and confusion; and 1875

to 1879, the period of slow and painful return to a solid specie basis.

1. The product per hand went up from 776 tons to 1,219 tons.

2. The total product, 58,959 to 86,546.

3. Wages advanced from $353 per hand, per year, in a debased currency constantly *losing* a part of its purchasing power, to $486 in an improving currency, constantly *gaining* in its purchasing power.

4. The gross value of the product remained about the same.

5. The number of hands was reduced from 76 to 71.

6. Consumers gained the benefit of a reduction in price from $27.95 to $19.08.

7. The margin between the cost of materials and labor per ton and the market price went down from $9\frac{55}{100}$ to $1\frac{09}{100}$, and out of this margin were paid all the general expenses, insurance, taxes, and profits, if any at the last date. Who gained most, labor or capital?

You will observe that while the profits of capital went down to almost nothing, the wage of the first period would have purchased $12\frac{63}{100}$ tons of iron per year, and in the second period $25\frac{42}{100}$ tons. That is to say, the share of the laborer in his own product was doubled.

Ere long I shall have similar data in respect to the following arts: Woollen cassimeres, paper, iron ships, ploughs, Indian corn in Illinois, and I expect to secure similar statements regarding many other arts. They will all sustain the same phenomena of progress *from* poverty to welfare.

They will fully prove that there has been —

1. An increase of product in ratio to population, whether in respect to the product of agriculture, mines or factories; thus disproving in this country during this century, the so-called law of population propounded by Malthus, which has been the *bete noir* of economists ever since it was presented, and which I hold to be a mere *a priori* conception of an insular

student who could not foresee the potentiality of modern science.*

2. An increase in the rates of wages in money, accompanied by a decrease in the money cost, as well as in the labor cost of all production.

3. Steadier and more adequate employment for labor, both skilled and unskilled.

4. A steadily diminishing share of the total product secured by capital, whether under the name of either rent, interest or profit.

5. I also expect to prove that there is no sign of there being any law of diminishing returns from land; but on the contrary greater variety, greater quantity and greater value of the products of agriculture in ratio to the number of persons occupied therein; thus disproving another alleged law, that of diminishing returns from land in ratio to population, which constitutes another of the *a priori* conceptions of most of the economists.

Land which has become partially exhausted of its primitive fertility, has become, under intelligent cultivation, more productive than it ever was in its virgin state and now yields a far greater product in ratio to each one of the greater number of persons who dwell upon it, than it did when sparsely populated and treated as a mine and not as a laboratory. As an example of this witness Furman's method of raising cotton in Georgia. He brought old fields which had been exhausted by slave labor so that each acre would yield only one-eighth of a bale of cotton, or 60 pounds, up to two and even three bales

* This so-called law of population is, as you are all aware, that population tends to gain on the means of subsistence; if this is true, progress *from* poverty is temporary, progress *and* poverty are necessary. The whole discussion of the necessary relations of labor and capital has been vitiated by this *a priori* conception, for nearly a century, for which, in my judgment, there is not a shadow of proof.

I shall presently refer to the land question, but here let me say that I take issue with the English School of Economists on three points: —

1. On the so-called law of population as propounded by Malthus.
2. On the so-called law of diminishing returns from land.
3. On the Ricardian theory of rent, in which the properties of the soil are considered as the basis of rent, rather than the capacity of the man who works the soil.

of ginned cotton to an acre, and made a profit all the time except in the first year.

I now recall your attention to the fourth element in my analysis of the cotton factory by which it appears that even after the reduction in the rate of wages between 1883 and 1885, the lesser sum of wages in 1885 would have purchased more sheeting. So it would of other staple articles.

In the course of my study of wages, I reached a certain standard of 1880, of what at that date constituted the proportionate expenditure of three persons living on what $500 would buy.

In the census year the family group was a fraction under 5, but the working group was a fraction under 3. In treating factory operatives, who consist so largely of single women and young persons, we may assume that two average operatives sustain one other person, so that on the average wages of two, three were subsisted.

My standard of a good subsistence is as follows. It is based on the actual consumption of certain factory operatives in New England and the Middle States: —

Expenditure in all,			$500 00
	Proportion of each element.		
Meat, poultry and fish,	20 %	$100 00	
Butter, milk and cheese,	10 %	50 00	
Bread,	6 %	30 00	
Vegetables,	5 %	25 00	
Sugar and syrup,	4 %	20 00	
Tea and coffee,	2 %	10 00	
Eggs,	1 %	5 00	
Fruit, green and dry,	1 %	5 00	
Ice, salt, pepper, etc., etc.,	1 %	5 00	
Total for food,	50 %	$250 00	
Fuel, light, soap, and the like,	10 %	50 00	
Clothing,	20 %	100 00	
Rent and incidentals,	20 %	100 00	
Totals,	100 %	$500 00	

This ration is based substantially on facts. It gives each adult person disregarding small fractions of a cent, —

10 cents' worth of meat per day, which would be ½ to 1 lb., according to kind and quality.
5 cents' worth of dairy products; *i. e.*, ½ pint milk, 1½ oz. butter, a scrap of cheese.
3 cents' worth of bread, about ¾ lb.
2½ cents' worth of vegetables.
2 cents' worth of sugar and syrup.
1 cent's worth of tea and coffee.
½ cent's worth eggs, 1 each 2 days.
½ cent's worth fruit, green and dry.
½ cent's worth of salt, spice, ice, etc.

25 cents per day, or $1.75 per week.

This ration is rather large and it would vary somewhat with the sex of the operative; women consume less meat and more sugar, tea and coffee than men.

We will assume that two operatives —

Earning in 1883 $287 each, or	$574 00
Spent $500 on the support of three persons, in these proportions, *i. e.*, ...	500 00
And then saved, ...	$74 00

Now from actual examination by the agents through whose courtesy I have been aided, at the request of treasurers, I find that the following reductions in prices took place between 1883 and 1885: —

	1883.	Reduction.	Saving in 1885.
On meats, ...	$100 00	14%	$14 00
dairy, mainly on butter, .	50 00	10%	5 00
bread, ...	30 00	33%	10 00
vegetables, ...	25 00	30%	7 50
sugar and eggs, . .	25 00	30%	7 50
Saving on food in all, ...			$44 00
Reduction on cotton, woollen and worsted clothing, .	100 00	15%	15 00
On rent and incidentals, .	100 00	5%	5 00
Total saving, ...			$64 00

The reduction on rent, fuel, light and incidentals seems small, and is probably less than has occurred in most places. From other partial investigations I am of opinion that the general reduction in the cost of shelter, food and clothing between 1882 and 1885 has been over 15 per cent. rather than under, which would make the cost of subsistence on the foregoing basis $425 in 1885, against $500 in 1883.

If the proportion of meat is too great more bread and vegetables should be substituted on which the reduction in price has been greater.

Now let us see what were the results of all changes: —

1st. The reduction in the *rate* of wages did not result in as large a reduction in the *sums* of wages because the increased efficiency of the machinery had begun to tell and had begun to increase the product per hand.

COMPARISON.

Wages of 2 persons in 1883,	$574 00
Cost of subsistence,	500 00
Saving, $12\frac{89}{100}\%$	$74 00
Wages of 2 persons in 1885, at the reduced rate,	$540 00
Cost of the same subsistence as in 1883, at the reduced prices,	436 00
Saving, $19\frac{26}{100}\%$	$104 00

Thus you will observe that the *rate* of wages constitutes no standard or guide either to the cost of producing goods, or to the cost of subsisting a family. Higher rates of wages accompany or are the correlative of lower cost of production.

Lower rates of wages may yet yield as good a subsistence and a larger addition to savings: *i. e.*, to capital.

I should not be a Yankee if I did not take this opportunity to refer you to my little book on the Distribution of Products, in which this matter of wages is treated more fully and with less special application. A second edition is about to be printed, and I hope you will all buy it, because I want to be economically justified by recovering from the sale the considerable sum of money which it has cost me to publish it.

I do not mean to say that such improvement in condition has been the absolute result of the present period of depression in all cases, but such are some of the phenomena which attract little attention.

If I may use vernacular expressions, when prices fall and dividends stop, capital *squeals*.

When work stops and workmen are discharged labor *howls*, but the vast majority of both classes work on and make no noise whatever.

Neither sound may indicate any very grave disaster. Shrewd and sagacious men who control capital quietly trim their sails at such times, await events, study economy, investigate new methods of work and perhaps add a wing here or a weave shed there, substitute new machines for old, and when the ebb tide ceases and the young flood comes, they take it in its course and thus lead on to fortune; while we who imitate, but do not foresee or plan wisely, only begin to extend our works when everything is high and so we lead on to some other fellow's fortune.

(*Interpolation.*) The morning after I wrote that paragraph one of our members came in to tell me that an automatic sprinkler had saved him from a heavy loss the day before; he then added this information: "We have been engaged lately in losing all our money, but I want you to understand that that mill is now all full of new machinery and is as well protected as it can be, and we were never in such effective condition for work before." I observe that many very shrewd men are "*losing* all their money" in just the same way, and it reminds me of the answer made by an old spinner in Rhode Island when somebody asked him if he was making any money in his mill: "Oh, no," said he; "we never made any money, but we are always making spindles!"

So much for capital.

But all labor cannot wait; while those who are fully employed may find their wages reduced and yet thrive the more, many are not so fortunate as to keep employed at all. Mills are stopped, railroads cease to be built, and a few skilled and

many common laborers for a time can find no work, and they may suffer; but the number of the unemployed is always very much exaggerated, because they flock to cities and by their concentration seem more numerous than they really are.

Can you find a great many spare weavers just now? I think not. Where are they? Are there any really good mechanics suffering for work at present? I guess not. Is there really any great surplus except of the commonest of common labor? Where is it?

Are not hard times the best schoolmaster? Are you not all preparing to do more work with less hands, and are you not certain of keeping the cost down even when wages go up again, as they must ere long?

This country is full of all the elements of prosperity.

An excess of land waiting to be used!

An excess of fixed capital waiting to be worked!

An excess of quick capital waiting to be consumed!

An excess of labor waiting to be employed!

What wait we for? I verily believe only for certainty as to what the standard of value shall be. If the present administration could only find in the acknowledged obscurity and doubt about the meaning of the Bland act for the coinage of silver dollars a reason for suspending action under it until Congress should render its provisions more clear, the wheels of industry might whirl again so that no Congress would dare to imperil the business of the country by continuing the attempt to force an 83 cent dollar into circulation in place of one worth 100 cents, to which latter standard all prices and wages are or would be adjusted by next December.

But now let me call your attention to some of the dangers which capital must surmount in order to maintain itself. Since 1866 the owners of factories have been subjected to two difficulties:

1. The reduction of currency values to gold.

2. The destructive force of new inventions and the substistution of new and more effective machinery for old.

In the process of moving our office old documents came to light, among them the first computation made by an insurance officer of the value of an insured cotton factory, such as we now make of all.

Mr. Whiting was called upon to value a mill in 1865 at the price of new machinery of the same kind, and also the cost of the buildings and equipment at that date.

Upon this valuation the owners, who desired to dissolve partnership, bid the rates of depreciation, until one party bought and the other sold.

Against these prices and cost of 1865 we have placed those of 1885; the result is a reduction from $28 per spindle to 11\frac{91}{100}$.

It is true that the difference on machinery and shafting is only $12 reduced to 7\frac{26}{100}$, but when you consider the work which can be done in the mill of 1865, however well it may have been kept in repair, as compared to the mill which would now be put up, you will have the same realizing sense in imagination that some of you have in practice, of the difficulty of maintaining capital in a cotton mill.

Copy of an Estimate of the cost of a Cotton Mill made by Mr. Wm. B. Whiting, from a **Price List** of **August, 1865.**				Prices of February, **1885.**	
2 Whitin Lappers, . .	@	$1,500 00	$3,000	@ $1,200 00	$2,400
36-36 Whitin Cards, with Slippers, (@ $204, adding $100 per card for Clothing, .	=	304 00	10,944	Cards, $122 / Cloth'g, 53 = 175 00	6,300
1 Breaker Railway Head, .		–	175	–	175
1 Doubler, ...		–	200	–	200
2 Finisher Railway Heads, .	@	280 00	560	@ 180 00	360
16 Rollers, Drawing, . .	@	70 00	1,120	@ 50 00	800
2 Slubbers, 64 spin., each .	@	24 00	3,072	@ 16 50	2,112
2 Inter, 128 spin., each . .	@	14 00	3,584	@ 12 00	3,072
8 Fly Frames, 144 spin., each	@	12 00	13,824	@ 7 50	8,640
3,200 Ring Spindles, . . .	@	5 50	17,600	@ 2 65	8,480
3,960 Mule Spindles, . . .	@	3 10	12,276	@ 1 85	7,326
200 Spooler Spindles, . .	@	3 00	600	@ 2 85	570
3 Warpers, ...	@	120 00	360	@ 200 00	600
3 Whitin Dressers, . .	@	1,400 00	4,200	@ 425 00	1,275
108 Whitin Looms, . . .	@	90 00	9,720	@ 60 00	6,480
			$81,235		$48,790

Cost per Spindle.		Cost per Spindle.	
Spin. 7,160) 81,235 ($11.34		Spin. 7,160) 48,790 ($6 81	
Add for shafting 5½ lbs. per spindle @ 12 cts., . . .	$11 34 66	Shafting, . .	45
Machinery and shafting, per spindle, ...	$12 00		$7 26
About 4 sq. ft. of building is requisite per spindle; and if this cost $2.50 per foot, it would be $10 per spindle, and carry the cost of building and machinery up to $22, leaving for water wheels, belts, apparatus, tools and furniture a margin of $6 per spindle to bring the mill at . . $28 per spindle		4 sq. ft. of flooring @ 80 cts.,	3 20
		Water wheels, belts, furniture, apparatus and tools,	1 45
			$11 91

It is probable that the cost of the buildings, water wheels, etc., estimated in 1865, were fully estimated, and the computation for 1885 will be considered low. If a suitable addition be made for foundations, the difference will yet show a reduction of more than 50 per cent.*

* Lawrence, Mass., May 8, 1885.

Dear Atkinson:

I have been carefully over your estimate of cost of mill building, and am inclined to think that you have got the last part of it too low.

You allow 80 cents per square foot and 4 feet per spindle for buildings. Now, 4 feet is the minimum for room, and gives you no outside buildings, for office, cloth room and repair shop.

Some estimates just made here for a storehouse, five floors, one of them concrete, no upper floor, foot up 70 cents per square foot, — 8½ feet stories.

Now, make these stories 14 feet and put on a good upper floor, and it will bring it up to $1 00 per foot, or $4.00 per spindle; and, if outside buildings are needed, you will have to allow about $5.00 per spindle. For power and fittings you allow $1.45 per spindle. Now, the cost about three years ago for two large mills, of 1,000 horse power each (where it is cheaper than for smaller ones), was, in either case, for steam plant, — *i. e.*, engine, boilers, house, chimney, etc., etc., in one, and for wheels, jack shaft and main pulleys in the other, — about $75,000; or, at an average of 60 spindles per horse power, $1.25 per spindle.

To this add, cost of belts, steam and water pipes, gas pipes or dynamos, elevators, sprinklers, reeds and harness, cans, boxes and all fittings, — I cannot call it less than $1.00 per spindle (and cheap at that), making $2.25 per spindle + $4.00 = $6.25, to add to machinery and shafting.

As mills are built and fitted in Lowell and Lawrence, and in New Hampshire, I should not want to estimate a satisfactory job much less than $15 per spindle, knowing that three or four years since only they cost about $19.

Mr. Parker, Mr. Battles, Mr. Oliver the engineer, have all looked at this matter with me, and agree with my conclusions, and I send you these notes to look over before the report is printed, in case you think it worth while to *enlarge* a little.

Yours most truly,

Saml. Webber.

I venture to think that I have fully proved that there has been and can be no oppression in the necessary relations of labor and capital. On the contrary they are interdependent, and there is nothing so conducive to the prosperity of capitalists as quick markets and high wages, nothing so adverse as low wages and slow sales. Labor suffers most when capital is securing the least measure of profit.

What is capital? Let us forget capitalists and consider capital, whoever may possess it. There are very few capitalists, and none too much capital, except for a moment. The art of controlling and directing capital in large and effective masses is one of the rarest qualities. The whole sum of all the capital of the nation, for the use of which any charge can be made, does not exceed in value two years' production.

Capital is a force which saves laborers from hardship and penury, by vastly increasing the fruits of their labor. It is a beneficent power which makes for the material welfare of every man, woman and child in all the broad land. It works for the general welfare from necessity, and not from choice, and even those who own and control it may have the least conception of their true function; while those who are most jealous of its power, and suspicious of its owners, would themselves starve if it were not used in their behalf. Neither labor nor capital can escape from each other; they are two phases of the same force; they are interdependent; they must co-operate even when competition is most urgent. Such is their necessary relation.

You will pardon me if I treat this subject for a moment in the most elementary way, for such is the only method of demonstrating the *necessary* relations of labor and capital.

Disregarding laborers and capitalists, let us consider labor and capital distinct from persons, but simply as forces.

As I have, I believe, once said to you before, the cotton fibre is the only one which nature gives us ready for use without any preparation, and we can imagine the time when the first woman, attracted by the white fleece just bursting from

purpose is to prevent capital from oppressing labor, the fault is not with capital, it is with capitalists and land monopolists. Again, I ask, what is capital? Is it not a product of labor saved for future use? — a reserved force only? If such is the true and only definition it may be unnecessary to ask who shall direct its use: the man who saved it or the man who did not save it? If it is conceded that the man who saves it shall direct its use, then the capitalist is justified. I have already shown you what a struggle he has to keep it.

But, says the land reformer, land is not capital; what right have you to monopolize land? It is true that land is not capital, but it is also true that it has no value whatever except so far as capital is applied to its use or occupation. It is also true that, in this country at least, there is no monopoly of land; and now I ask you to consider this next table, and to prove to you that if poverty oppresses this land, and is to be found in the heart of our great cities as intense, if not in as great a measure, as in London, Paris or Berlin, it is not lack of land which causes it,— not even lack of *national* land. We have been trying for half a century to *de-nationalize* land, and to give it away, in order to get it into use. How much is there of it, and what have we done with it?

In this table I have dealt in a rough and ready way with the areas occupied, or which might serve, for all our great crops. The area of the United States, omitting Alaska, is a trifle less than 3,000,000 square miles.

In a broad and general way we may assume that one half this area is good arable land, one quarter good pasture land, and one quarter forest, mountain, and mining territory.

TOTAL AREA.

3,000,000 square miles.

Graphically shown by the four lines,

Mountain and Timber.

1–4.

Grazing.

1-4.

Arable.

1-2.

INDIAN CORN FIELD.

112,500 square miles.

At 25 bushels to an acre this area produces 1,800,000,000 bushels. This corn is largely converted into pork at the rate of 5 lbs. of corn to one pound of pork. Assuming one thousand million bushels thus converted, and the rest used for human or cattle food, the product of pork would be equal to 18,500,000 casks or its equivalent in bacon; which would give nearly one cask of pork of 300 lbs. to each head of a group of three persons per year, or 100 lbs. per capita.

WHEAT FIELD.

60,000 square miles.

At 13 bushels per acre this little area yields a little over 500,000,000 bushels. Setting aside an ample portion for seed this quantity would give over 80,000,000 persons one barrel of flour per year.

COTTON FIELD.

20,000 square miles.

At the wretched average of only half a bale to an acre this little patch yields 6,400,000 bales in a year.

WOOL.

What the actual area of sheep pasturage is no man can tell, because the area of land absolutely free to graziers and ranchers is so large that no question of area has arisen until within a very short time; but the end of this wasteful and archaic method can be foreseen. When the cur-dog shall have been muzzled, or when dogs shall have been declared *feræ naturæ*, it will be easily possible to sustain four

sheep to an acre over wide areas of unoccupied land in the East and South as well as in the far West; this would require a sheepfold of

40,000 sq. miles,

sustaining 102,400,000 sheep, which at only 4 lbs. each would yield more wool than we now consume of all kinds, both domestic and foreign.

DAIRY FARMS AND HEN YARDS.

In 1880 the number of milch cows was estimated at 12,-500,000, and the product of eggs was computed at 500,000,000 dozen, valued at $80,000,000. Over how wide a range of pasturage the milch cows ranged it is impossible to say, but almost within the period which has elapsed since 1880 it has been proved entirely possible to feed two cows one year on the corn-stalks saved in pits which can be raised on one acre of fairly good land, if to this green fodder be added a ration of meal made from the cotton seed which was almost all wasted until a very recent time, and is yet saved in only a very small proportion. But in order to be safe we may reverse this ratio, and assigning only one cow to two acres we may greatly increase our present ration of milk, butter, and cheese, with the hens' eggs thrown in.

A Dairy Farm and Hen Yard
of 60,000 square miles,

at 1 cow to 2 acres, will sustain 19,200,000 cows.

BEEF.

The relative importance of meat in the subsistence of our people has been shown in the foregoing table. A large portion of our beef is now produced by almost semi-barbarous methods on the far-distant plains; but as population increases this rude way must give place to more civilized and humane modes, and our beef must be produced near its place of consumption. Many Eastern farms which had ceased to be profitable have lately been converted into *beef factories*, upon which steers are raised and fattened on ensilage and corn-meal. Provision has

been made for the cornfield, and if pitted forage is as fully justified on a broad scale as it has been in the successful experiments of many able men who have applied brains and capital to the use of land, it would be necessary to assign only a small area to beef.

60,000 square miles,

at 500 lbs. of meat to an acre, would yield nearly one pound of beef per day to our present population (reckoning two children as one adult).

If these propositions can be sustained, it follows that our present crops of corn, wheat and cotton, and a very much increased product of the dairy and poultry-yard, as well as of meat and wool, can be raised on

352,500 square miles,

or upon twelve per cent. of the total area; and even this assignment of land is nearly double what might be required if the *intensive* system of farming were adopted by men of sufficient intelligence and capital to conduct all parts of the work in a reasonably good way.

It is held that in the face of this demonstration the charge that poverty is now to be attributed to monopoly of land in this country is utterly disproved, and that the explanation of extreme poverty must be sought in other directions. It is painfully apparent that extreme poverty is to be found chiefly among those who are foreign born, but there is as much free land open to them as there is to the native born, — enough and to spare for both.

It may therefore well be questioned whether the more intense and widespread poverty of European countries can be attributed mainly, even if in part, to the systems of land tenure there prevailing, if the same phenomena are to be found in the heart of the great cities of this country, where there is so much free land as in those of countries where land is fully occupied.

Want oppresses New York, Boston and Philadelphia, of the

same kind if not in as great a degree as London, Paris and Berlin. Yet in the United States land is in excess of the utmost need; in England it is held by the few rather than the many, and in France and Germany by the many rather than by the few. It follows, almost as a matter of necessary deduction from these phenomena, that the great problem is the distribution of the product of the soil rather than the distribution of the soil itself. The greater part of those who only suffer in cities might starve if removed therefrom and placed upon unoccupied land where they would depend only upon themselves for subsistence.

What other reason can there be for the very poor to gravitate to the cities, if the struggle to obtain food and shelter is not a little less severe there that it would be in the country?

In order that material welfare may exist at all, labor and capital must both be applied to land. Land is valueless without labor, — labor is almost helpless without capital. Is not this the reason why the unemployed flock to the cities, where the capital is, and never go to the free land unless moved there and sustained by the capital of others until they can possess land and capital of their own?

What is the necessary conclusion from all these facts?

We have land in excess of our utmost present need but it lies waste, — useless and valueless, for lack of labor and capital.

We have capital wasting away for lack of laborers to make use of it.

We have laborers waiting for work, crowding together in our cities and suffering from want.

What is the remedy? One says in Protection; another says in Free Trade. One says in an eight-hour law; another says in no restriction on free contract; another says in compulsory weekly payments. One says in co-operation; another says in absolutely free competition. One says in saving; another says in spending.

Let us examine all these phases of proposed legislative or of collective action by one single standard.

Can either one of you help a man permanently who cannot help himself? Can you qualify him to support himself by legislation, co-operation or otherwise? Can you make him more capable of self-support by eight hours' work when he can't support himself now by ten or more?

Here is land lying waste all over Massachusetts, and even houses falling into ruin, upon which our own grandfathers secured comfort and welfare, even when almost unaided by capital.

Choose among the unemployed to-day those only who are sound and strong, place them upon this land, repair these houses for their use, lend them capital in the form of better tools than perhaps even your own fathers worked with while sustaining you in your early days. What will they do with their time, the only thing which all possess in common? Will they prove to be individually capable of sustaining themselves or their families? Sometimes, *yes;* but, alas, sometimes *no.*

What can we do for them?

This is the problem which is pressing upon us, and which *must* be solved.

It matters not that the general plane of subsistence, comfort and welfare is rising. It matters not that a larger and larger proportion, even of those who must for the time be sorted as belonging to the "working classes," can obtain a better subsistence and more comfort with less effort to-day, than ever before. Admit all this, prove all this, prove yet more, that men and women become discontented to-day with a standard of wages and of subsistence which would have far more than satisfied their predecessors. The best definition of man almost ever given is "that he is the only animal endowed with progressive desires." In such discontent or progressive desire is the source of personal ambition, of economy, of industry and of progress. Who among us who began life with only his own brain and hand for his capital would be where he is except he had been discontented?

But is there not in modern society another class, mostly con-

sisting of those who have come from foreign lands, who have not yet learned the open secret of this country — who have been kept down by circumstances until they have themselves become too old to learn the new methods of their newly adopted land?

What shall we do for them?

I know of no class of men upon whom a graver responsibility rests than upon you, and those like you, upon whose judgment, forbearance and sense of responsibility rests the welfare of a multitude.

You are employed by those who work for you as truly as they are employed by you, and in the service which you render as well as that which you receive may be found your own justification as well as the justification of the capital which you direct.

The power which makes for righteousness has also established all the conditions which make for material welfare in the truest sense, for each and all.

Our Mother Earth yearns to support *all* her children in comfort, and the World waits for the humanity of commerce in which all men serve each other.

Labor saved is but a reserve of power.

The river may run its wild way and waste its force, but if it is held back and directed through the water wheel — if in the reservoir it is converted into capital — it moves the machinery in the use of which one woman does the work that it required one hundred to do before.

Must the ninety and nine suffer want? *Yes*, if individually incapable of any other work than working a spinning-wheel or a hand-loom. *No*, if individually capable of grasping the opportunity and the time which is offered them by the relief from the drudgery of their previous work.

It follows of necessity that the *necessary relations* of labor and capital will demonstrate themselves only when each *individual* has become capable of applying both or either to useful service. The labor question is one of *personal* capacity,

industry and character; when these are present the highest wages will be earned by those who, aided by capital, take part in the lowest cost of production, — then progress *from* poverty will be assured as the common rule of society, subject only to personal misfortunes, for the relief of which charity must always be called in and for which it will always suffice.

Until personal capacity, industry and character are assured, progress *and* poverty will continue to exist, — not because of any malignant relation between capital and labor, but because their necessary relations are obstructed by ignorance of the higher laws under which society itself exists.

BOSTON, May 1, 1885.

AMBROSE EASTMAN, ESQ., *Secretary.*

DEAR SIR: — The Association desired the tables which I used in illustration of my address to be printed with it, to which I most gladly assent; but in order that their purpose may be fully comprehended, I suggest that the text of the two communications to Bradstreet's be printed with them, with this letter in explanation.

Yours very truly,

EDWARD ATKINSON.

OCCUPATIONS AND EARNINGS.

To the Editor of Bradstreet's:

SIR, — In the study of the forces which make the rate of wages, my attention has been called to the relative proportions of the various occupations of the people of this country. The tables of occupations of all who were engaged in gainful employments may be accepted as one of the most accurate in the

census of 1880, in view of the fact that the same enumerators who counted the population also made this list, and each person enumerated gave his own occupation.

The census classification is into four groups, viz.:

1. Farmers and farm laborers.
2. Professional and personal service.
3. Trade and transportation.
4. Manufactures, mechanics and mining.

The following sectional groupings under these heads is suggestive:

PROPORTION OF THE PERSONS IN EACH 1,000 OF ALL WHO WERE OCCUPIED IN ANY KIND OF GAINFUL EMPLOYMENT IN THE CENSUS YEAR. TOTAL NUMBER, 17,392,099. I. FARMERS AND FARM LABORERS. II. PROFESSIONAL AND PERSONAL SERVICE. III. TRADE AND TRANSPORTATION. IV. MANUFACTURING, MECHANICAL AND MINING.

1. In the whole country.

I.—F. & F. L.	II.—Prof. & Pers.	III.—T. & T.	IV.—M. & M.	
441.	234.	104.	221.	1,000

2. Southern States, included Delaware and Missouri.

I.—F. & F.	II.—P. & P.	III.	IV.—M.&M.	
646.	196.	63.	95.	1,000

3. New England States.

I.—F. & F. L.	II.—P. & P.	III.—T. & T.	IV.—M. & M.	
172.	223.	134.	451.	1,000

4. Middle States, exclusive of Delaware.

I.—F. & F. L.	II.—P. & P.	III.—T. & T.	IV.—M. & M.	
197.	293.	157.	353.	1,000

5. Western and Northwestern States and Territories.

I.—F. & F. L.	II.—P. & P.	III.—T. & T.	IV.—M. & M.	
442.	242.	107.	209.	1,000

This classification is not wholly satisfactory, and in order that a clearer view may be given the chart below has been prepared.

For this classification into seven groups only approximate accuracy can be claimed, for reasons which are given hereafter; but the main feature, to wit, the relatively low grade of the work, and therefore low wages of a very large portion of the people, is unpleasantly conspicuous. A little less than one in three of the whole population is engaged in gainful work, and if my computations are approximately correct about 80 to 85 per cent. of the whole population must find shelter, subsistence and clothing out of what 40 to 45 cents, or possibly 50 cents, per day will buy.* When depression reduces even this low measure, what wonder that trouble ensues if injustice is suspected in the social order by the uninformed or ignorant?

In this classification the specific numbers in each separate occupation are sometimes given exactly and sometimes by computing together in round approximate figures those whose occupations are analogous. The shading in the graphical lines is intended to show approximately the proportion of each class whose earnings may be above the average of annual income as compared with those whose earnings are at that rate or below it. No absolute data exists for making this separation. It is by estimate only.

Assuming one person in each 2.90 to be engaged in gainful occupation, which is the average, 45 cents per day average expenditure per person implies a yearly expenditure of a little over $475, which would be, approximately, $500 for each group of three persons, or $833 for a family of five. It will be evident that this is a high rather than a low estimate for the expenditure of working people, and it must be remembered that five cents per day additional to each person of our present population amounts to over one thousand million dollars a year.

* See "The Distribution of Products," published by G. P. Putnam's Sons.

CLASS.	No. in each 1,000.	Computed Total Number.	
1. Mental, . . .	40	696,000	20 20 — Clergymen, 64,968; lawyers, 64,137; physicians and surgeons, 85,671: teachers and literary, 227,710; journalists, 12,308; scientists and engineers, 8,126; musicians, 30,477; officers of corporations, banks, railroads, insurance and others, 202,468.
2. Mental and manual, .	60	1,044,000	30 30 — Merchants and traders, 481,450; hotel keepers, 32,543; clerks, salesmen, commercial travellers, brokers and all others engaged in the purchase and sale of goods, 521,898.
3. Automatic machinery,	100	1,740,000	20 80 — Collective factory work, textiles, printing and bleaching, 500,000; metals and machinery, 300,000; clothing, 450,000; boots, shoes and hats, 210,000; all others, 280,000.
4. Hand and mach. tools,	107	1,861,800	30 77 — Mechanical, not collective, carpenters, coopers and other workers in wood, 500,000; blacksmiths, 172,726; painters, 128,556; masons, 102,473; all others, 958,045.
5. Manual, . . .	131	2,279,400	40 91 — Service, express, railroad, telegraph employés (not laborers), 300,000; domestic servants, 1,075,655; laundry, 122,000; waiters, 200,000; draymen, hackmen, etc. 180,000; all others, 391,345.
6. Horse and hand tools,	250	4,350,000	50 200 — Farmers, herdsmen, stock-breeders and the like.
Manual, etc., . . .	312	5,420,899	10 302 — Laborers on farms, 3,323,876; laborers not specified, probably in part on farms, 1,857,023; miners, 240,000.
Total, . . .	1,000	17,392,899	

In class I, consisting of persons whose work is purely mental, are to be found all teachers, country clergymen, literary persons, journalists and the like, numbering more than one-half the whole number; and in this category will be found a very large number whose purchasing power is not on the average above that of a first-class mechanic. In class II, one-half the number consists of clerks, salesmen, saleswomen and other minor employés, whose purchasing power would stand between that of a factory operative and a good mechanic.

Subdividing these two classes we then have among every 1,000 in purchasing power —

GRADE I.		
Persons of high purchasing power—		
Class I, one-half,	20	
Class II, one-half,	30	
To these may be added perhaps one-fifth of class VI, prosperous farmers,	50—	100
GRADE II.		
Medium purchasing power—		
Class I, teachers, etc., one-half,	20	
Class II, clerks, etc., one-half,	30	
Class III, factory and machine-shop operatives, all,	100	
Class IV, mechanics, all,	107	
Class VI, two-fifths of the farmers,	100—	357
GRADE III.		
Lowest purchasing power—		
Class V, servants, etc.,	131	
Class VI, two-fifths of the farmers,	100	
Class VII, laborers,	312—	543
Total,		1,000

From this analysis it will appear how much the activity of trade may depend upon the purchasing and consuming power of Grade III, numbering more than one-half the whole working force.

Let it be remembered that in 1882 about 650,000 men, mostly laborers, were employed in the mere construction of

railroads, and that in 1884 not exceeding 220,000 were occupied in this work. Let it next be remembered that in 1880, 1881 and 1882 there was a rapid and progressive increase in the number of factories and works of all kinds, which had almost wholly ceased in 1884, from which cessation perhaps not less than 250,000 men must have been thrown out of employment. In these two facts we have evidence of lack of customary employment for about 680,000 men, or nearly 8 per cent. of the whole consuming force in Grades II and III.

Whenever this partly idle force shall have been placed on new land or found new work, or whenever confidence and capital begin to work together on the old lines, the present depression may end and prosperity may be renewed.

It is the common laborer who suffers first in a period of depression, and if I am even approximately correct in my estimate of the number of laborers discharged by the cessation in the construction of railways, mills and works, not less than one-quarter of all the laborers not listed as on farms have thus suffered.

We may well refrain from harsh comments on the existing discontent when we reflect that the limit of shelter, subsistence and clothing for the greater part of the people of this prosperous land must be found within what forty or forty-five cents a day will purchase for each person — man, woman or child.

Only approximate accuracy can be claimed for the analysis contained in this table, because the groups are not capable of absolute definition. It is suggestive rather than conclusive. For instance, all who were occupied as machinists, on clothing, boots or shoes, milliners and the like, have been placed in the collective factory work, because such is the tendency of these arts; but many such persons belong in the mechanical group, not collective but individual.

On the other hand, many of those placed in the latter class are doubtless connected with large factories. There is less uncertainty in regard to the other groups.

One thing is, however, very certain, and that is that by far

the greater portion of all who are occupied in any gainful work are in the position of wage-laborers or small farmers, and therefore any cause of depression which impairs their purchasing power by lack of employment, or by reducing their wages or earnings, must react with very great severity upon the profits of manufacturers and merchants. So far from the interests of the several classes being antagonistic, they are interdependent, and there is nothing so adverse to high profits as low wages. Where is the remedy?

The period of depression through which we are passing is very similar to that which ensued after the so-called panic of 1873, and may find the same remedy, unless the world is really overstocked with products of agriculture, a condition which at any rate cannot last long. Given a demand for grain, meat and dairy products, the land still offers relief, and it is in a redistribution of laborers upon new land that relief must soon come.

It will be observed that in this, as in other periods of depression, the sales of government and of railroad lands have been very large; but the change in the distribution of labor by a transfer to new land is very slow, and a long time elapses before new settlers become large consumers of manufactured goods.

The cessation of constructive enterprise in 1872-3 was very sudden, the redistribution of laborers afterward was very slow, but by January 1, 1879, when the specie standard was restored and all doubt ceased as to the stability of the currency, every condition was ripe for the activity and prosperity which ensued.

In the same way, and in even greater measure, after the excessive railway construction of this decade culminated in 1882, the cessation of constructive activity in all directions was sharp and severe, but since then the redistribution of labor has been steadily progressing, and if all doubts as to the stability of the currency could be again removed by the cessation of the coinage of silver a period of activity and prosperity might quickly come.

Our population is now gaining with great rapidity, and the absolute demand for the shelter, clothing, subsistence and additional means of communication for this increase cannot be long held in abeyance. The country is full of all the elements of wealth, and just as the restoration of the specie standard in 1879 gave the necessary confidence then, so might the cessation of the coinage of silver dollars give confidence in the stability of the standard of value now, so that the activity and prosperity of 1880 might recur in 1885 if Congress would act at once.

EDWARD ATKINSON.

BOSTON, February 2.

THE SILVER BUSINESS ANALYZED.

To the Editor of BRADSTREET'S.

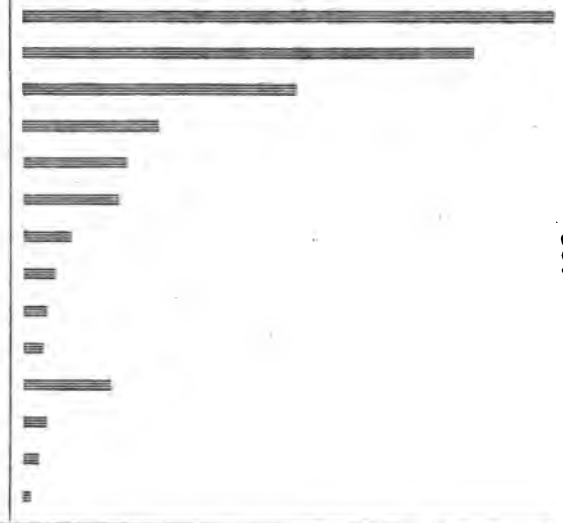
SIR: — It is possible, by a graphic comparison of the annual value of our product of silver with those of food, clothing and other staples — at present reckoned on the gold basis of 100c. to the dollar — to give a clearer notion of the confusion into which the business of the country is sure to be thrown should the acts for the enforced coinage of silver not be repealed.

The following table gives the relative value of the silver product of the United States, shown by a comparison with some other important articles of consumption. The value of the articles of food given is on the basis of the average consumption of each person in the United States (counting two children under ten as one person), being equal to the ascertained consumption of cotton factory operatives in New England and in the middle states. The estimates of the value of clothing and other articles made from fibres, and of cotton, wool and iron are approximate, but sufficiently accurate for purposes of comparison. Population reckoned at 50,000,000 adults.

Our actual population is probably about 57,000,000, but in this table I have counted two children of 10 or under as one adult.

The data of consumption vary in slight measure from the standard given before, but are the exact averages of the two factory boarding houses from which the figures were taken. It is not probable that the average consumption of sugar, tea and coffee is as large as this table indicates. The occupants of these houses were mostly women, who consume more sugar, tea and coffee, and less meat, than men.

1.	Meat, poultry and fish, 9 7-10c. worth per day,	$1,765,000,000
2.	Clothing, carpets, etc., $30 per year each,	1,500,000,000
3.	Dairy — ½ pint milk, 1½ oz. butter, scrap cheese, all 5c. per day,	912,500,000
4.	Bread — 1 bbl. flour per year, bread at 2½c. per day,	456,000,000
5.	Vegetables at a cost of 1 98-100c. per day,	360,500,000
6.	Sugar and syrup, 1 94-100c. per day,	353,000,000
7.	Tea and coffee, 1 2-100c. per day,	185,000,000
8.	Fruit, green and dry, 62-100c. per day,	113,000,000
9.	Domestic eggs, 1 every other day, 12c. per dozen,	91,250,000
10.	Salt, spices, ice, etc., 49-100c. per day,	89,000,000
11.	The cotton crop, 6,000,000 bales, at $50,	300,000,000
12.	The pig iron product, 4,250,000 tons, at $20,	85,000,000
13.	The wool crop, 320,000,000 lbs., at 20c.,	64,000,000
Silver product, at gold value, only,		40,000,000



The consumption of spirits, beer and wine has lately been computed by Mr. David A. Wells at about $475,000,000. At retail prices it would probably be more rather than less. It is doubtless true that a larger sum is expended for liquor than for bread.

The value of the total consumption of the United States is now about $11,400,000,000, against $10,000,000,000, or a little more, in 1880. The graphical line would be nearly six and a half times the upper line (shown above), with which compare the fly-speck which represents silver. More than one-half of the silver production is purchased by the Treasury for coinage.

Omitting raw cotton and raw wool, and treating pig iron separately, the foregoing list of articles of food and clothing amounts to $5,800,000,000. It represents a somewhat less sum than is probably paid by the people of the United States for such articles. The basis of the table, so far as food is concerned, is on the standard of the actual consumption of factory operatives, at a cost of $23\frac{85}{100}$c. per day, or $1.67 per week. It is probable that the average cost in money of the food of adults is more than this, although it is not probable that they average as good a ratio for their money, the food of these operatives being bought at wholesale prices. On the whole, food and clothing cost the consumers of this country about $6,500,000,000 on the basis of the present population. Pig iron, when converted into its final form, probably adds $300,000,000, and there still remain timber, stone and all material for shelter to be added. Whatever the final amount may be, the prices are now adjusted to the standard of the gold dollar, rated at 100c.

When the standard is changed to silver at 84c. to 85c., as it surely will be unless the coinage of legal tender silver dollars is soon stopped, the prices of this immense volume of consumable commodities must rise in just the proportion that the standard of value is lowered. This rise will be very slow, because consumption has been so much reduced by uncertainty. The probabilities are that while this adjustment is in process

wages will keep where they are or go lower, while the money cost of living will become greater.

The absolute necessity of preparation for an increasing population may counteract these tendencies in a measure, but on the whole depression and want of work will be continued, in the face of rising prices and increased cost of subsistence.

The legislators who sustain the present acts of coinage, which are approved neither by bimetallists nor monometallists, will be responsible for the disturbance which will ensue.

Mr. Draper. I understood Mr. Atkinson to make the statement that a large portion of the factory property was hereditary, owned by people who inherited it from their fathers. My own judgment about that matter is that he is mistaken. I heard Mr. Dalton make the same very remarkable statement as to the ownership of the mills of Lowell and Lawrence. In my own experience, I do not know a man worth $100,000 within ten miles of my factory who has not been a wage laborer.

Mr. Atkinson. Mr. Draper misapprehends me. I merely said, admitting for the sake of the argument that most of the factories are owned as inherited wealth, what of it? I did not make that assertion, but I said it would make no difference if it were so. I know it has been said "there are but three generations from shirt sleeves to shirt sleeves," to which I have added, provided the disabilities of wealth have left anybody in the fourth generation to put on shirts. [Laughter.]

The President. I suppose a discussion of this paper is in order, or if there is anything else to be brought before the meeting, it is now in order.

Mr. Kilburn. I move that the thanks of this association be tendered to Mr. Atkinson for the able manner in which he has presented this subject of the relations of labor and capital. [Adopted.]

On motion of Mr. Kilburn it was voted, That Mr. Atkinson

be requested to furnish the tables prepared by him, for publication in the report of this meeting.

Mr. Atkinson. I shall be happy to furnish them.

Mr. Whitaker. I should like to ask one question of Mr. Atkinson concerning the linen and cotton bands which he spoke of. I would like to know which of them proved to be the best.

Mr. Atkinson. When the question of banding came up before, being a theorist, I thought that I could protect the bands with paraffine wax, so as to avoid the effects of changes of atmosphere, and thus get a positive band; but like some other theories, which are not founded upon facts, it proved fallacious, for that band stretched more than any other, because the wax made the fibres of cotton slippery and did more harm in that way than by protecting the bands from the action of humidity. But it then occurred to me that there was something in the nature of the fibres of cotton and linen which would give a clew, —the cotton fibre, being like a corkscrew or twisted ribbon, would stretch when damp; but linen, being a cylinder, would swell when damp, and therefore take up or shrink in the twist. I therefore had some banding made of cotton and flax in certain proportions, each strong enough to bear the strain, but one shrinking when the other stretched. That band, with various other bands, was subjected to every variety of atmospheric influence and was saturated with moisture and made as dry as it could be made. That band, being made of a proper length for a spinning frame, changed in its length less than one inch, while the one that was treated with paraffine wax I think stretched thirteen inches. It was one hundred inches long. One theory was as fully justified as the other was ill-advised. I have that original composite band. I am prepared to patent it if there is any prospect of its being useful. I have not given it away, and I believe there is something in that composite band. I think you can get more nearly to a positive band with that mixture of fibres than you can in any other way.

Mr. WHITAKER. Can any of these best bands be had for present use?

Mr. ATKINSON. There is not enough for a frame. You can simply get some linen cord and some cotton twist and have them braided together in different proportions. I remember that we tried two or three different proportions of flax and cotton, and one proportion was better than the others.

Mr. WOODBURY. There were some proportions which were twisted together which did not give so satisfactory results as where cotton braid was braided round a linen core, so that the cotton was continuous from end to end and the linen continuous from end to end. Where cotton and flax were intermixed they seemed to slip upon each other. It is quite necessary, I believe, for the outside of such bands to be made of cotton. If the cotton is on the inside, the flax will soon glaze over.

Mr. WHITAKER. I have asked these questions of Mr. Atkinson, because I believe that the average side pull of the band in ring spinning is, ordinarily, excessive; and that it is entirely practicable to lessen this average side pull, and, with it, to lessen materially the present excessive consumption of power in spinning. It frequently occurs that one-half of the power that is used in a cotton mill is consumed in spinning. The proportion was lessened considerably, ten or twelve years ago, by the introduction of the Sawyer and other light spindles. It has increased to its former dimensions with increase of speed. I reported this morning that at about 9,100 revolutions per minute of the New Rabbeth spindle, the number of spindles per horse-power had been increased to 103, an increase of nearly 56 per cent., by simply stretching the over-tight bands. Yet the stretched bands were undoubtedly tighter than was necessary for good work. In how many of our mills are the New Rabbeth spindles running at 9,100 revolutions per minute with 103 spindles to the horse-power? I believe that this record will be exceeded in practical work, when as much intelligent attention as is profitable shall be devoted to the pre-

vention of waste of power in spinning. I believe, also, that the spindles, frames and bands will last longer when this waste of power has been prevented.

Mr. Atkinson. A discussion on this subject came up years ago when Mr. Draper was agitating the question of a four-ounce spindle, I think, and I laughed at him. I said: "When you get your spindle down so very small, with full tension on your band, it will spring your spindle and you will need more power than if you had a heavy spindle, properly banded." Afterward it became expedient to test friction on spinning and to find out the amount of oil that was necessary (and the band question was involved in that); later came the invention of the band tester, made by Mr. Draper, and we found a variation of from one and a half to sixteen pounds on the same frame.

Mr. Whitaker. I had intended, this morning, to call attention to this Power Scale, which is larger than the Cotton Mill Power Scale which I then described, but which is of the same general design. It is intended to be permanently attached to a main shaft, and to indicate, continually, the power which is transmitted to the shaft. The machine is made in halves, therefore it can readily be attached without taking the shaft down. If one of these scales, of the right size and in good order, is attached to the main shaft of a spinning room, one can see at any time whether the whole of the machinery in the room is consuming more power than is necessary. If it is, the machine or the machines, which are out of order, can be quickly detected by the aid of the small, portable Cotton Mill Power Scale.

There are large mills, in which more than 1,500 horse-power is consumed in spinning, at a cost of, say, thirty dollars per horse-power per year, or $45,000 per year, for power used in spinning alone. I believe that an intelligent experimental study of the problem will point out the way by which the manager of such a mill can save a very considerable portion of that sum, if he will make an outlay that is trivial in proportion to the saving.

The CHAIRMAN. Will you state the amount of power, at a given speed, which that machine will record?

Mr. WHITAKER. I cannot at this moment. I beg permission to refer that question to Mr. Earl A. Thissell, who is present, and who is the manager of the Emerson Power Scale Company.

Mr. THISSELL. The maximum capacity of a No. 1 Scale, at 100 revolutions of the shaft, is two horse-power; at 400 revolutions of the shaft, it would be four times that. We have constructed on that same plan five sizes, of different capacities. The largest one, at 200 revolutions of the shaft, is capable of weighing 360 horse-power. We have one of that kind at Holyoke, on a shaft running ten sets of woollen machinery. At Lowell we had one on a shaft which ran six months continuously without any apparent wear; so that, practically, I think this is as durable as any machine in the mill.

A year ago last August this invention was brought to my notice, and I have been working upon it ever since. The reason which led me to take hold of it was, that I believed that the want of a convenient and accurate means of weighing power was the only reason why it had always, practically, been made, sold and used by guess, while every other known commodity was sold either by weight or measure. We have now got the machine where it satisfies every test to which Prof. Whitaker has subjected it, and in its perfection, I believe, the desired end is accomplished.

While I was sitting here this morning, listening to the explanation which Prof. Whitaker gave of the manner in which he made his tests, I heard the remark that it was an advertising dodge. If it is, I think it a very good one for the people who will use it, because I am of the opinion that power enough can be saved in any manufactory to light their rooms with electric light, by the use of these power scales, and reducing the expense for power to what it ought to cost them to run their machinery.

The PRESIDENT *pro tem.* Since our last meeting one of our members, and one who has been a vice-president or director of the New England Cotton Manufacturing Association for many years, has passed away. I do not know that it would be improper for any one, at this time, to say a few words concerning our former associate, William F. Goulding.

Mr. ATKINSON. Mr. President, I ought to have thought of that myself without being moved by you. I happened to be connected, in a subordinate position, with the owners of the Androscoggin Mills at the time our late friend took charge of their construction, and for many years afterward I was brought into very close relations with him while he was the principal manager of companies whose financial affairs were under my charge. I can only bear my testimony in a few simple words, which are perhaps all that are needed. Mr. Goulding was a man of thorough integrity, of honesty of purpose and sincerity, — able in his place, a true friend to those whom he employed, and true to the service of those who employed him. If such a record can be made of each of us, what more have we to ask?

Adjourned.